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IMPACT ASSESSMENT REPORT

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COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

Forging a climate-resilient Europe - The new EU Strategy on Adaptation to Climate Change

{COM(2021) 82 final} - {SEC(2021) 89 final} - {SWD(2021) 26 final}

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1. INTRODUCTION

Global warming is happening and is already affecting Europeans – its impacts are here and now and they are a daily confirmation of the case for urgent action that science has provided for some time. Temperatures continue to break records and climate-related extreme events are more frequent and more intense. Europeans continue to call for stronger climate action even in the current health and economic crisis resulting from the Covid-19 pandemic. This means higher ambition on both mitigation and on adaptation to climate change[1].

The impacts on people, planet and prosperity are already pervasive but unevenly distributed across the globe. In 2018, most of the natural hazards affecting nearly 62 million people globally were associated with extreme weather and climate events[2]. Out of 17.2 million new displacements associated with disasters in 2018, 16.1 million were weather related[3]. Between 2000 and 2016, the number of people exposed to heatwaves globally increased by around 125 million[4]. Climate-related disasters doubled compared to the previous 20 years[5]. At the global level, least developed countries and small island states are particularly vulnerable to the impacts of climate change and have the lowest adaptive capacity, while at the same time contributing the least to greenhouse gas emissions. Climate change also impacts disproportionately the most vulnerable parts of our society, thus exacerbating inequalities further. The changing climate has reduced oxygen levels in the ocean by ~1-2 % since the middle of the last century[6], while increasing ocean temperatures have resulted in habitat shifts for species and coral bleaching (causing worldwide reef degradation).

Moreover, **even stopping all greenhouse gas emissions would not stop the climate impacts that are already occurring**, and which, due to the concentration of these gases in the atmosphere, are likely to continue for decades. Temporary decreases of greenhouse gas emissions, like those caused by the 2008 financial crisis or the current economic disruption from the Covid-19 pandemic, have little effect on the evolution of the planetary climate (and emissions can bounce back quickly).

The global temperature averages (already 1.2°C above pre-industrial levels) hide even more extreme regional impacts. An average of 3°C or 4°C global rise in temperature means temperature increases above 5°C or 6°C for some regions (and Europe warms faster than the average). This ranges from unprecedented forest fires and heatwaves above the Arctic Circle to increasingly devastating droughts in Western Europe and the Mediterranean region; and from accelerating coastal erosion on the Atlantic coast to more severe flooding and decimated forests in Central and Eastern Europe[7].

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[1] In this impact assessment, Adaptation refers to policies, practices and projects which can moderate damage, improve resilience and/or realise opportunities associated with the impacts of climate change at all levels of society.
[2] https://library.wmo.int/index.php?lvl=notice_display&id=20799#.XmIqSKhKjb0
[3] https://www.internal-displacement.org/sites/default/files/publications/documents/2019-IDMC- GRID.pdf
[4] https://www.who.int/health-topics/heatwaves#tab=tab_1
[5] https://www.undrr.org/news/drrday-report-dramatic-rise-climate-disasters-over-last-20-years
[6] https://portals.iucn.org/library/node/48892
[7] The 2020 State of the European environment report concludes that climate change has substantially increased the occurrence of climate and weather extremes.

Without drastic emission abatement measures (at a global scale, matching the EU goal on climate neutrality by 2050 and increased ambition by 2030), continued climate change will increase the likelihood of severe, pervasive and irreversible consequences such as the decline or collapse of natural ecosystems (e.g. Arctic or Alpine ecosystems), the erosion of global food security, or displacement of people[8]. Extreme sea level events and floods will occur more frequently, with severe damages to Europe's coastal communities. Climate change and its impact is interrelated with other environmental crisis (biodiversity loss, natural resources depletion, pollution); their effects are cumulative – but solutions are also common.

European Union political and legal context

The 2013 EU Adaptation Strategy[9] was evaluated in November 2018[10]. The Evaluation found that the strategy had delivered on its objectives, with progress recorded against each of its eight individual actions. Nevertheless, several areas of societal vulnerability were identified for improvement, drawing on lessons learnt from implementation, and in the light of international developments since its adoption (such as the Paris Agreement[11] and the Sendai Framework for Disaster Risk Reduction[12]).

The European Green Deal[13] sets out the Commission's commitment to tackling climate and environmental-related challenges and introduces the green oath to "do no harm". It is essential as a roadmap and a growth strategy towards a prosperous, resilient and healthy future, made more necessary in light of the very severe effects of the COVID-19 pandemic on our health and economic well-being. Unprecedented near term investments will be needed to overcome the negative impact of the COVID-19 crisis on jobs, incomes and businesses. The political choices we make today will define the future for the next generations. A new, more ambitious Adaptation Strategy was announced in the European Green Deal Communication, and subsequently as part of the Commission Work Programme 2021[14]. An extensive Blueprint[15] informed the public debate with citizens and stakeholders on the new Strategy.

Recent calls to raise the ambition of the EU strategic approach to climate change adaptation build on earlier progress[16]. These take place against a background of increasing public visibility of climate change impacts (both current and projected – see section 2) and other environmental problems that has also led to direct calls for action from citizens and civil society. There has been a corresponding increase in attention from EU Institutions:

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[8] https://www.eea.europa.eu/highlights/soer2020-europes-environment-state-and-outlook-report

[9] European Commission (2013) An EU Strategy on adaptation to climate change, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions COM/2013/0216 final

[10] European Commission (2018) Evaluation of the EU Strategy on adaptation to climate change, Report from the Commission to the European Parliament and the Council SWD/2018/461 final

[11] Council Decision (2016) On the conclusion, on behalf of the European Union, of the Paris Agreement adopted under the United Nations Framework Convention on Climate Change, (EU) 2016/1841 (OJ L 282, 19.10.2016, p. 1)

[12] European Commission (2014) The post 2015 Hyogo Framework for Action: Managing risks to achieve resilience, Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions COM/2014/0216 final

[13] European Commission (2019) The European Green Deal, Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions COM/2019/640 final

[14] European Commission (2020) Commission Work Programme 2020 A Union that strives for more, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions COM/2020/37 final

[15] European Commission (2020) Adaptation to Climate Change Blueprint for a new, more ambitious EU strategy

[16] For a more detailed account of the historical background, the interested reader is directed to the 2018 Evaluation of the Adaptation Strategy, which provides a comprehensive review up to 2018.

European Council conclusions repeatedly stress the need for further action on adaptation[17], the European Parliament Resolution on the new EU Strategy[18] considers it as an opportunity to show the EU global leadership on adaptation.

Over the next decade, the implementation of the European Green Deal would further deliver on European climate change adaptation ambitions, with adaptation to address climate change impacts as a key priority, as impacts will continue to create significant stress despite mitigation efforts. The Commission proposal for a European Climate Law Regulation[19], establishing the framework for achieving climate neutrality in the EU and at the heart of the Green Deal, recognises adaptation as a key component of the long-term global response to climate change. It requires Member States and the Union to enhance their adaptive capacity, strengthen resilience and reduce vulnerability to climate change. It also introduces a requirement for the implementation of national strategies and regular progress assessments as part of the overall EU governance on climate action.

The new Strategy will step-up the ongoing drive to mainstream adaptation considerations in EU legislation and instruments, as adaptation affects almost the entire spectrum of EU policy. Climate change adaptation is being mainstreamed in new initiatives under the European Green Deal, including the EU Biodiversity Strategy[20], the Farm to Fork Strategy[21], the Circular Economy Action Plan[22], the Renovation Wave[23], the Forest Strategy[24] the Urban Agenda for the EU[25] and the Habitat III new Urban Agenda[26],the Sustainable Development 2030 Agenda[27], and the Zero Pollution ambition. Other channels for mainstreaming of adaptation in EU policy include the implementation of the EU's Strategic partnership with the EU's outermost regions[28] and cooperation with the European Standardisation Organisations[29]. Most recently, the implementing regulation on the Governance of the Energy Union and Climate Action [30] [31] stipulates the structure, format, submission processes and review of adaptation information reported by Member States[32].

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[17] Council conclusions on Climate Diplomacy, ST-5033-2020 of 20 January 2020, https://data.consilium.europa.eu/doc/document/ST-5033-2020-INIT/en/pdf

[18] European Parliament resolution of 17 December 2020 on the EU strategy on adaptation to climate change (2020/2532(RSP)) https://www.europarl.europa.eu/doceo/document/TA-9-2020-0382_EN.pdf

[19] European Commission (2020) Proposal for a Regulation of the European Parliament and of the Council establishing the framework for achieving climate neutrality and amending Regulation (EU) 2018/1999 (European Climate Law), COM/2020/80 final

[20] European Commission (2020) EU Biodiversity Strategy for 2030, from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, COM/2020/380 final

[21] European Commission (2020) Farm to Fork Strategy, from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, COM/2020/381 final

[22] European Commission (2020) A new Circular Economy Action Plan For a cleaner and more competitive Europe, from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, COM/2017/0623 final

[23] European Commission (2020) A Renovation Wave for Europe - greening our buildings, creating jobs, improving lives COM(2020) 662 final

[24] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12674-Forests-new-EU-strategy

[25] https://ec.europa.eu/futurium/en/urban-agenda

[26] https://www.habitat3.org/the-new-urban-agenda

[27] https://www.international.gc.ca/world-monde/issues_development-enjeux_developpement/priorities-priorites/agenda-programme.aspx?lang=eng

[28] European Commission (2017) A stronger and renewed strategic partnership with the EU's outermost regions, from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, COM/2020/98 final

[29] Mandated in 2014 by the Commission, CEN-CENELEC's Coordination Group 'Adaptation to Climate Change' (ACC-CG) supports the implementation of the new EU Adaptation Strategy by coordinating activities relating to standardisation. Currently, the ACC-CG coordinates the process of revising 12 existing standards in the buildings, energy, transport and ICT sectors, and is exploring other sectors where adaptation to climate change is identified as necessary.

[30] European Parliament (2018) Governance of the Energy Union and Climate Action, of the European Parliament and of the Council, Regulation (EU) 2018/1999,

[31] European Commission (2020), on structure, format, submission processes and review of information reported by Member States pursuant to Regulation (EU) 2018/1999, of the European Parliament and of the Council, Regulation (EU) No 2020/1208

[32] An updated list of Developing Countries and Least Developed Countries can be found, respectively, at the Word Bank's and IMF's official websites

This reporting also supports national energy and climate plans (NECPs), e.g. by protecting the security of the Union's energy supply against climate impacts[33].

The European Commission has been instrumental in taking forward the 2015 Sendai Framework for Disaster Risk Reduction (DRR) through its Communication setting out initial views on shaping the post-2015 Hyogo Framework for Action[34]. In November 2017, a communication from the Commission highlighted the need for Strengthening EU Disaster Management through "rescEU - Solidarity with Responsibility"[35] and in 2019 the revised Union Civil Protection Mechanism was published[36]. The mechanism promotes more robust and comprehensive EU disaster management through the contribution of all the Union's policies and instruments to reinforce the capacity to prevent, prepare for, respond to, and recover from disasters, including climate-driven natural disasters. [37]

Local engagement was identified as an area for improvement in the evaluation of the 2013 Strategy[38], which called for more ambition in the adoption, implementation and monitoring of national, regional and local adaptation strategies. As part of the European Green Deal, the Commission [will] launch a European Climate Pact to give actors at all levels a voice and space to design new climate actions, share information, launch grassroots activities, and highlight solutions that others can follow, including on adaptation. At the local level, the Covenant of Mayors is one of the EU's key initiatives for responding to the climate emergency and for steering local and regional authorities (LRAs) in the transition towards climate neutrality and climate change adaptation. Today bringing together more than 10,400 signatories in Europe, the Covenant, alongside other regional and local institutions and institutions, represents a key complement to the involvement of local and regional authorities in drawing up NECPs.

The new Adaptation strategy anticipates the demands created by other initiatives in supplying a larger array of solutions and information on adaptation. The European Green Deal Investment Plan[39] is the investment pillar of the European Green Deal and is intended to mobilise at least EUR 1 trillion of private and public sustainable investments over the upcoming decade, including climate action, and climate resilience will be an important beneficiary of the delivery of this ambition. To further help direct and mobilise sustainable investments, the Commission committed to review Directive 2014/95/EU on Non-Financial Reporting Directive (NFRD)[40]. The NFRD requires companies to report on non-financial issues annually, including the environment, social and employee issues and human rights. In particular, the Taxonomy Regulation (2019/2088)[41] requires companies under the scope of the NFRD to disclose certain indicators of the proportion of their activities that are classified as sustainable. Moreover, the Delegated Act on the Sustainable Finance Taxonomy[42] further

[33] https://www.eea.europa.eu/publications/adaptation-in-energy-system
[34] European Commission (2014) The post 2015 Hyogo Framework for Action: Managing risks to achieve resilience COM/2014/0216 final
[35] European Commission (2017) Strengthening EU Disaster Management: rescEU Solidarity with Responsibility Solidarity with Responsibility, from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Communication COM/2017/0773, final
[36] Decision (EU) 2019/420 of the European Parliament and of the Council of 13 March 2019 amending Decision No 1313/2013/EU on a Union Civil Protection Mechanism (OJL77 I, 20.3.2019, p.1.)
[37] In June 2020 a further review of the UCPM was proposed (COM(2020)220 final of 2.6.2020.
[38] European Commission (2018) Evaluation of the EU Strategy on adaptation to climate change SWD/2018/461 final
[39] European Commission (2020) Sustainable Europe Investment Plan European Green Deal Investment Plan, from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, COM/2020/21
[40] European Parliament (2014) amending Directive 2013/34/EU as regards disclosure of non-financial and diversity information by certain large undertakings and groups, of the European Parliament and of the Council Regulation (EU) No 2014/95/EU
[41] European Parliament (2020) on the establishment of a framework to facilitate sustainable investment, and amending Regulation, of the European Parliament and of the Council Regulation (EU) No 2019/2088
[42] https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance/eu-taxonomy-sustainable-activities_en

specifies technical screening criteria for making a significant contribution to adaptation. Together, these developments are expected to encourage reporting firms to invest in sustainable activities, including activities that build climate resilience. Overall, this will also create a wider pool of sustainable investment projects available for adaptation action, as well as increase demand for the adaptation solutions, tools and knowledge to be developed by the Strategy.

International political and legal context

There is increasing prominence of adaptation needs in the international public agenda. The World Economic Forum listed extreme weather and climate-change policy failures as the gravest threats[43] for several years in a row. Moreover, international actors like the World Bank[44] and the International Monetary Fund[45] are responding to the growing attention to climate risks and the need for adaptation.

In 2010, the UNFCCC Conference of the Parties established the Cancun Adaptation Framework[46] to strengthen adaptation action in developing countries through international cooperation. The Conference also established an Adaptation Committee to promote the implementation of stronger adaptation action, provide technical support and guidance to countries, strengthen knowledge sharing and promote synergy between stakeholders.

These decisions paved the way for the adoption in 2015 of the Paris Agreement, the new global framework for renewed ambition in reducing greenhouse gas emissions and in implementing adaptation measures[47]. Among its milestone objectives, the Paris Agreement enshrines the global goal on adaptation of enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change. The Paris Agreement set up a Global Stocktake to review the overall progress made in achieving the global goal on adaptation, and the Paris Decision provides the Adaptation Committee with a comprehensive mandate to support the work and substantiate the consideration of progress towards the global goal of adaptation.

At EU level, the implementing regulation for the Governance of the Energy Union and Climate Action also asks Member States to share information on the provision of financial, technological and capacity-building support to developing countries. It thus facilitates the implementation of the Union's commitments under the UN Framework Convention on Climate Change (UNFCCC) and the Paris Agreement.

The European Union launched the “Global Climate Change Alliance” (GCCA) flagship initiative in 2007[48]. Its second iteration (GCCA+) had amongst its priority areas to support the formulation and implementation of concrete and integrated sector-based climate change adaptation and mitigation strategies in Small Island Developing States and Least Developed Countries. The new EU Development Cooperation programme for 2021-2027 (under preparation) brings opportunities for enhanced support and partnerships - the new Strategy will help by giving a greater focus to adaptation.

[43] https://www.weforum.org/reports/the-global-risks-report-2020
[44] https://www.worldbank.org/en/news/press-release/2019/01/15/world-bank-group-announces-50-billion-over-five-years-for-climate-adaptation-and-resilience
[45] https://blogs.imf.org/2019/12/02/straight-talk-the-adaptive-age/
[46] UNFCCC (2010) The Cancun Adaptation Framework, https://www.unsystem.org/content/unfccc-cancun-adaptation-framework
[47] https://www4.unfccc.int/sites/ndcstaging/Pages/LatestSubmissions.aspx
[48] https://ec.europa.eu/clima/sites/clima/files/docs/gcca_brochure_en.pdf

The 2030 Sustainable Development Goals[49] (SDGs) lay down the specific objective to "take urgent action to combat climate change and its impacts" (Goal 13). Progress towards the SDGs is likely to increase resilience to climate change (e.g. SDGs on hunger, water, health, and ecosystems) or address some of the fundamental causes of climate change (e.g. by SDGs on energy, infrastructure, cities, and consumption and production)[50]. Additionally, the Union supports cities to exchange solutions and jointly tackle adaptation challenges, thereby making a direct contribution to the UN-Habitat New Urban Agenda and SDGs.

Impacts of COVID-19 on EU adaptation policies: resilient recovery

Climate change hazards are compounding the COVID-19 outbreak and its economic effects, e.g. cardiovascular and chronic pulmonary disease — recognized risk factors for severe Covid-19 — are closely linked to climate change, through effects including extreme heat, ground-level ozone, wildfire smoke, and increased pollen counts over longer seasons (i.e. 'compound risk')[51]. Although the final impacts of COVID-19 cannot yet be determined, there is recognition of a lack of preparation for potentially compounding crises, such as the incidence of extreme wildfires and heatwaves, together with the current health crisis.[52] Examples of the added complexity of such compound problems include the difficulty of respecting social distancing during a crisis like wildfires or flooding, or enforcing confinement policies during heatwaves.

The European Union has argued that fighting climate change should be central to Europe's economic recovery from the coronavirus pandemic[53], including in its Recovery and Resilience Facility, the Renovation Wave and other initiatives. Similar calls for adaptation measures and investments to play a key role in the recovery are echoed by the IMF[54].

Similarities exist between the problem drivers of the COVID-19 pandemic and climate change adaptation: in both cases, decision-makers and societies are subjected to a 'normality bias', which leads people to underestimate the likelihood of a disaster.[55] The onset of the pandemic also led to triggering the Union Civil Protection Mechanism and extending its scope on stockpiling of medical equipment for instance. The inclusion of pandemics as risks that the EU may face emphasises the links with other forms of disasters[56].

While climate change is relatively slow-onset compared to the pandemic's spread, for both the lag between measures and effects, and the trade-offs between immediate economic costs and long-term health benefits make it difficult for political leaders to take immediate bold action. Lastly, the link between climate change and health impacts in Europe was further reinforced by a recent European Environment Agency (EEA) analysis[57], e.g. with the latest evidence that climate change, together with air pollution, noise, chemicals, contributes to the

[49] United Nations (2015) Transforming our world: the 2030 Agenda for Sustainable Development, by the General Assembly, Resolution A/RES/70/1

[50] An overview at the level of the sub-goals is made by several, including the ETC/CCA in this report https://www.eionet.europa.eu/etcs/etc-cca/products/etc-cca-reports/tp_3-2018

[51] Salas, R. N., Shultz, J. M., & Solomon, C. G. (2020). The Climate Crisis and Covid-19—A Major Threat to the Pandemic Response. New England Journal of Medicine.

[52] OECD (2020), Report of Special meeting of the Task Force on Climate Change Adaptation (30/06/2020).

[53] General Secretariat of the Council (2020). Conclusions adopted in Special meeting of the European Council (17,18, 19, 20 and 21 July).

[54] https://www.imf.org/en/Publications/FM/Issues/2020/09/30/october-2020-fiscal-monitor

[55] OECD (n.d.). Recovery for Resilience (R4R). Policy brief. Not published, available upon request.

[56] 2020 edition of the SWD 'Overview of natural and man-made disaster risks the EU may face

[57] EEA Report No 21/2019 https://www.eea.europa.eu/publications/healthy-environment-healthy-lives

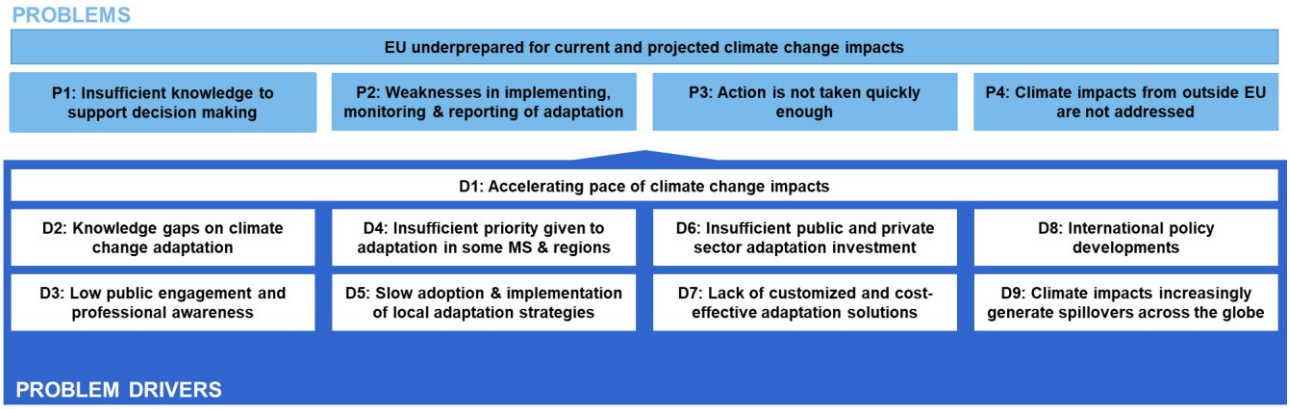
burden of cardiovascular disease, while noise, chemicals and climate change all drive neuropsychiatric disorders[58].

[58] Further evidence on these links is available from the scientific opinion on 'Adaptation to climate change-related health effects' published in June 2020 by the European Commission's independent Group of Chief Scientific Advisors (SAM). Source: https://ec.europa.eu/info/news/new-scientific-opinion-adaptation-climate-change-related-health-effects-recommends-more-support-resilience-health-sector-2020-jun-29_en

2. PROBLEM DEFINITION

This chapter discusses the problem tree that must be addressed by the new Strategy, stemming from the fact that **the EU is still underprepared for current and projected climate change impacts**. This problem tree builds on the problem analysis of the 2013 Strategy and its Evaluation, extensive foresight into projected climate impacts carried out by the Joint Research Centre (hereafter referred to as PESETA)[59], assessments by the EEA (both at national[60] and local/regional level[61]) and contributions from stakeholders. Figure 1 provides an overview of the problem definition; drivers and problems are described in detail in following sections.

Figure 1: Problem definition for the new EU Adaptation Strategy



Drivers are numbered (D1-D9), as are the Problems (P1-P4) and (in chapter 4) Objectives (O1-O4). These numbers are used later in this report as a guide to the development of policy options. The figure can be read as a flow in columns, whilst noting that the problems and drivers are mutually reinforcing and/or overlapping.

Problems for the new EU Adaptation Strategy and their evolution

P1: Insufficient knowledge to support decision making

There is a lack of relevant indicators and meaningful data for informing, and assessing national and local adaptation action. Data and knowledge gaps cut across all drivers and problems in various ways: from knowledge or data that is not available to knowledge that is not reaching the necessary audiences and decision makers; and from data that is not available at the level, or in a form to be useful to the lack of skills/knowledge to understand the data and make adequate decisions. Data is needed to enable stakeholders to validate their progress in implementing adaptation actions; to enable policy makers to maintain, simplify, and strengthen climate policies, and to enable researchers and innovators to explore novel adaptation solutions.

When available, climate data and projections to anticipate impacts are frequently not available at the local level, where many critical decisions need to be taken. Similarly, adaptation solutions are often either not customised for the local specificities or not yet tested on a large enough scale to facilitate replication elsewhere. Integrating climate change adaptation in local governance frameworks has been raised in prior studies as a

[59] Feyen L., Ciscar J.C., Gosling S., Ibarreta D., Soria A. (editors) (2020). Climate change impacts and adaptation in Europe. JRC PESETA IV final report. EUR 30180EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-76-18123-1, doi:10.2760/171121, JRC119178.
[60] EEA Report No 6/2020 Monitoring and evaluation of national adaptation policies throughout the policy cycle.
[61] EEA Report No 12/2020 Urban adaptation in Europe: how cities and towns respond to climate change

limiting factor for effective adaptation action[62]. An analysis of 885 European cities sought to investigate the extent to which a mainstreaming approach was used in local climate planning as compared with a dedicated approach, i.e. dedicated stand-alone climate policy documents.[63] The results highlighted the importance of choosing either a "dual-track approach" in which municipalities develop and adopt the dedicated and mainstreaming plan simultaneously, or first focus on a dedicated approach and later mainstream local climate issues. This would encourage effective implementation of tangible climate actions as well as subsequent diffusion of climate issues into other local sector policies.

There is a lack of appropriate methodologies and indicators to integrate climate change adaptation with disaster risk reduction strategies. Climate-related disaster loss and risk data are important not only for crafting and implementing National Adaptation Plans (NAP) and Strategies (NAS), but also for disaster risk assessment and management, risk monitoring, risk modelling, loss accounting, economic and social policy, accessing the EU Solidarity Fund, local authority planning, and the provision of green investments. Despite the usefulness of these types of data, they are currently not widely available to public authorities, research institutions, and other stakeholders. The available data is often incongruous, inconsistent over time, lacking the granularity and standardisation required to draw comparisons across regions and Member States. The data is also often incomplete: for certain perils there is only information on the number of people affected (insured and uninsured), the economic losses (indirect and direct), and the affected area. Moreover, non-economic losses (e.g. environmental degradation of ecosystems, reduction in biodiversity, destruction of items of cultural significance, emotional and psychological damages) are entirely absent from existing datasets.

P2: Weaknesses in implementing, monitoring and reporting of adaptation action

There is currently only limited agreement on principles, requirements and guidelines for adaptation. This results in the lack of a common method for systematic monitoring and evaluating the implementation of adaptation policies. For public investment, The Monitoring Mechanism Regulation (to be replaced by the provisions of the Energy Union Governance Regulation from 2021 onwards) requires Member States to report to the Commission on their adaptation activities. [64] The regulation does not prescribe a definition for adaptation activities nor a methodology to track adaptation activities, so it continues to be a challenge to compare progress between Member States or to track horizontal progress on the Strategy's objectives[65].

For private investment, a problem identified in the Strategy's Evaluation is the tracking of private finance flows for adaptation action in Europe, which would allow for a clear understanding of how investments needs are being met by the private sector. Indicators that are more relevant are needed to accurately monitor private sector commitments to adaptation.

[62] Idem
[63] Reckien, D., et al. (2019) Dedicated versus mainstreaming approaches in local climate plans in Europe. Renewable and Sustainable Energy Reviews 112: 948-959.
[64] COM(2016) 759: Proposal for a Regulation of the European Parliament and of the Council on the Governance of the Energy Union, amending Directive 94/22/EC, Directive 98/70/EC, Directive 2009/31/EC, Regulation (EC) No 663/2009, Regulation (EC) No 715/2009, Directive 2009/73/EC, Council Directive 2009/119/EC, Directive 2010/31/EU, Directive 2012/27/EU, Directive 2013/30/EU and Council Directive (EU) 2015/652 and repealing Regulation (EU) No 525/2013
[65] EEA Report No 6/2020 Monitoring and evaluation of national adaptation policies throughout the policy cycle.

In this regard, the EU Taxonomy on Sustainable Finance provides a possible common metric for the EU for the development of associated incentives and verification measures.[66]

The lack of effective mechanisms to monitor and report on the implementation of national and local strategies hinders progress. The recent policy developments and increased public awareness highlight the need for a comprehensive monitoring and evaluation system to effectively measure progress. New tools that allow assessment not only of preparedness (as in the 2013 Strategy), but also of resilience, and which monitor it over time, would need to be complemented by relevant and comparable indicators among EU countries.

The 2018 Evaluation concluded that more should be done in this area, particularly for the transport, construction, and energy sectors[67]. Other work has pointed to deficiencies in EU level monitoring and reporting of adaptation spending.[68,69] The 2018 Evaluation also concluded that Member States' monitoring and reporting on their NAS and/or NAP is not yet robust and there is a need to develop stakeholder involvement (including at subnational levels) in their assessment, evaluation and review. The evolution from the EU Greenhouse Gas Monitoring Mechanism Regulation (MMR)[70] to the Energy Union Governance Regulation from 2021 onwards for Member State reporting on adaptation activities is an opportunity to redefine the role for adaptation preparedness scoreboards.[71] Similarly, at city level, although the pledges by cities are increasing, it is unclear to what extent these are turned to action, indicating more should be done to track progress at the local level[72].

The unevenness of progress in the development of climate change adaptation agendas across Europe is reflected in the adoption of the NAS and NAP, which are published on the Climate-ADAPT platform.[73] By April 2020, all 27 EU Member States had adopted a NAP and/or NAS. Nonetheless, many are not yet in the implementation stage. For example, Italy, Ireland, Slovakia, Slovenia, Greece, Hungary, and Poland have not yet adopted NAPs, while many more have yet to establish monitoring indicators and methodologies[74].

Cross-boundary effects of climate impacts within the EU are also not sufficiently considered. The 2018 Evaluation of the Adaptation Strategy indicated that transboundary cooperation within the EU remains relatively weak.[75] The strong cross-border dimension of many climate change impacts stresses the need for enhanced cooperation to advance towards effective cross border climate change adaptation strategies as well[76]. Nonetheless, the unevenness of climate change adaptation agendas is also seen in the approaches implemented by countries across Europe to comprehensively reduce and adapt to climate-related risks. Opportunities for transboundary cooperation should be more systematically considered, e.g. in the fields of freshwater, wildfires, transport infrastructure, telecommunication, energy

[66] European Technical Expert Group on Sustainable Finance (2020). Financing a sustainable European Economy. Taxonomy Report: Technical Annex.
[67] https://www.eea.europa.eu/publications/adaptation-in-energy-system
[68] Grzebieluch, B., Dembek, A., Meier, N., & European Parliament. (2018). The EU spending on fight against climate change. April. https://www.europarl.europa.eu/RegData/etudes/IDAN/2018/603830/IPOL_IDA(2018)603830_EN.pdf
[69] https://www.oecd.org/dac/environment-development/Revised%20climate%20marker%20handbook_FINAL.pdf
[70] Regulation (EU) No 525/2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and repealing Decision No 280/2004/Ec.
[71] The adaptation preparedness scoreboard aims to create an overview of Member States' adaptation policies. See for more information: EEA (n.d.). Working Document on the Adaptation Preparedness Scoreboard.
[72] The recently published EEA report provides evidence for this point: https://www.eea.europa.eu/publications/urban-adaptation-in-europe
[73] Climate Adapt- Country profiles. https://climate-adapt.eea.europa.eu/
[74] EEA Report No 6/2020 Monitoring and evaluation of national adaptation policies throughout the policy cycle.
[75] European Commission (2018) Study to support the evaluation of the EU Adaptation Strategy, Final Report – available at https://ec.europa.eu/clima/sites/clima/files/adaptation/what/docs/adapt_strat_eval_report_en.pdf
[76] https://www.eea.europa.eu/themes/climate-change-adaptation/adaptation-policies/adaptation-policies-in-transnational-regions.

infrastructure[77] and other types of 'critical infrastructure'.[78] Climate hazard impacts to critical infrastructures and EU regional investments may rise strongly in Europe: modelling predicted that damages could already triple by the 2020s, could increase six-fold by mid-century, and could increase by more than ten-fold by the end of the century compared to a 1981-2010 baseline.[79] The EU Sendai Action Plan promotes resilient investments in critical infrastructure across EU countries, although the transboundary aspect could be strengthened.[80]

P3: Adaptation action is not taken quickly enough

Mainstreaming of adaptation in relevant policies is progressing, but at a suboptimal pace in light of the increasing frequency and intensity of the impacts. Although the increase in ambition for climate mainstreaming of 30% in the new Multiannual Financial Framework (2021-2027)[81] is likely to benefit adaptation action, the EU's tracking system for climate action does not differentiate between how much is spent on climate change mitigation and on adaptation.[82] Another issue is that economic models and financial decision-making tools used to underpin investments still do not include the damage costs and benefits of investments in resilience (climate risk assessments).[83]

Guidance for mainstreaming has been provided in some policy areas, but its effectiveness is unclear**.** The 2018 Evaluation noted that there is still a need to better understand how the guidance documents are being used by Member States**.** In its remarks on the new MFF 2021-2027, the European Court of Auditors (ECA) repeated its concerns regarding the Common Agricultural Policy (CAP) link to climate and environmental objectives[84], including adaptation, as this is not tracked in expenditure.[85] The Commission replied to ECA that a clear-cut separation between adaptation and mitigation, as well as for other environmental objective, is often not possible in agriculture and forestry. Given the importance of the CAP and Cohesion Policy in the total EU budget, these will remain crucial areas to address.

(Un-)insured losses and risks are inadequately reported and acted upon. The 2018 Evaluation identified the role of insurance and financial products in involving the private sector in adaptation and in mitigation of disaster risks as a key priority. A related issue is that the approach to insurance of climate risks varies widely across Member States. In a first step, it would be helpful to gather information on the approach adopted in each Member State in relation to public versus private insurance mechanisms, to assess where private insurance can make a significant contribution. A prerequisite for private insurance for climate risks is the sufficiency and robustness of data to put insurers in a position to build projections on the climate and to allow accurate assessment and pricing of those risks. However, even where

[77] https://www.eea.europa.eu/publications/adaptation-in-energy-system
[78] European Environment Agency (2017). Climate changes, impacts and vulnerabilities in Europe 2016. An indicator-based report. Retrieved from: https://www.eea.europa.eu/publications/climate-change-impacts-and-vulnerability-2016
[79] Forzieri, G., Bianchi, A., Marin Herrera, M.A., Batista e Silva, F., Feyen, L. and Lavalle, C., 2015. Resilience of large investments and critical infrastructures in Europe to climate change. EUR 27598 EN. Luxembourg (Luxembourg): Publications Office of the European Union.
[80]: Action Plan on the Sendai Framework for Disaster Risk Reduction 2015-2030, SWD(2016) 205 final/2.
[81] European Commission (October 2019). Time to decide on the Union's financial framework for 2021-2027 (COM). Retrieved from: https://ec.europa.eu/commission/publications/communication-time-decide-unions-financial-framework-2021-2027_en
[82] European Court of Auditors (2016). Spending at least one euro in every five from the EU budget on climate action: ambitious work underway, but at serious risk of falling short'.
[83] E3G (2017). Climate Risk and the EU Budget investing in resilience. Retrieved from: 7 European Court of Auditors (2017), Landscape review: EU action on energy and climate change
[84] European Court of Auditors (ECA) (2019): ECA remarks in brief on the Commission's legislative proposals for the next multiannual financial framework (MFF).
[85] European Commission – DG AGRI (2019). Evaluation study on the impact of the CAP on climate change and Greenhouse Gas emissions. Retrieved from: https://op.europa.eu/en/publication-detail/-/publication/29eee93e-9ed0-11e9-9d01-01aa75ed71a1/language-en/format-PDF

insurers have sufficient data, the insurance industry may not be willing or able to provide insurance against these risks at an affordable price where risk become too high.[86] The may lead to mismatches between insurers' premium and clients' ability to pay.

Moreover, not acting upon risks urgently will lead to distributional consequences, because regions will be affected differently based on their location, climate, population, legal system and geography. There is a clear north-south divide in the regional distribution of welfare losses, southern regions having aggregated welfare losses several times larger compared to those in the north of Europe,[87] and thus climate change may increase future intra-regional disparities.[88] Key economic sectors in regions will also be affected, such as tourism[89], agriculture and low-carbon energy[90], which could further exacerbate existing inequalities. Climate change can also heavily affect communities dependent on natural resources for traditional practices. Assessments of the role of socio-economic status and age also show higher exposures and vulnerabilities to climate health hazards, with concentrations in Southern Europe, due to higher proportions of elderly, rural and low-income people, who are particularly vulnerable.[91]

The varying effects of climate change on women and men and how climate impacts internationally may amplify gender inequalities (e.g. social responsibilities, practices) have also shown to be essential to any adaptation effort.[92,93]

P4: Climate impacts from outside the EU are not addressed

The EU strategic approach to adaptation and international developments need to be better aligned. The European Green Deal reaffirms that the global challenges of climate change and environmental degradation require a global response.[94] While the EU has pursued adaptation priorities internationally, particularly through its development cooperation activities, the Evaluation identified only limited integration of international activities into the broader climate change adaptation strategy. The current Strategy, nevertheless, does refer to transboundary issues in its guidance on the development of NASs, as well as in the priorities of the LIFE programme for adaptation flagship projects that address trans-regional issues.

At the same time, international policy developments such as the adoption of the Paris Agreement, the adoption of the UN Sustainable Development Goals and many others demonstrate that international climate change adaptation issues require further consideration by the EU in the new Strategy. The international angle is not only relevant from a climate and environmental policy perspective, but also to address foreign and security policy, e.g. effects in Europe from global climate change impacts on international stability and security, or on population displacement [95]. Moreover, the spillover effects matter from an economic

[86] Surminski & Eldridge (2015). Flood insurance in England: an assessment of the current and newly proposed insurance scheme in the context of rising flood risk. Journal of Flood Risk Management.
[87] Feyen L.et al (2020). Climate change impacts and adaptation in Europe. JRC PESETA IV final report.
[88] Kovats, R.S. et al (2014) Europe. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1267-1326.
[89] COACCH (2019). The Economic Cost of Climate Change in Europe: Synthesis Report on Interim Results.
[90] IPCC (2018) Global Warming of 1.5°C. Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways.
[91] Marí-Dell'Olmo, M., et al (2019) Social inequalities in the association between temperature and mortality in a South European context. Int. Journal of Public Health.
[92] Resurrección, B., et al. (2019) Gender-Transformative Climate Change Adaptation: Advancing Social Equity. Paper commissioned by the Global Commission on Adaptation (GCA)
[93] European Insitute for Gender Equality (2020) Women and the environment: climate change is gendered. Available at: https://eige.europa.eu/publications/beijing-25-policy-brief-area-k-women-and-environment
[94] European Commission (2019) The European Green Deal, section 3 'The EU as a Global Leader'.
[95] Council of the European Union (20 January 2020). Council Conclusions on Climate Diplomacy. Retrieved from:

perspective: global and EU supply chains (e.g. for EU agriculture and manufacturing) are already being disrupted, and increasingly so[96].

The implications of such transboundary effects of climate impacts in 3rd countries are not yet integrated in the EU adaptation policy, even if climate impacts in developing countries are already given considerable attention in the EU development policy. There is an increasing need for the EU to conduct further research and review existing evidence to inform guidance to Member States on how to tackle likely impacts from international spillover effects[97]. The EU, due to its geo-political, security, and trade ties with other countries, as well as its proximity to countries that are likely to be less able to adapt to climate change, is highly vulnerable to international spillover effects[98]. Thus, thorough assessments of the EU's exposure to international spillover effects, including of the EU's key global interdependencies and their related climate risks, are necessary.

Furthermore, EU support to developing countries' own adaptation efforts is in line with the EU's vision of global solidarity in facing climate change. In 2019, the EIB provided €3.2 billion in lending to support climate action. The European Commission provided €2.5 billion in finance to developing countries in 2019. While the global public finance flows in adaptation, with significant contribution from the EU and its Member States, is consistent and substantial, it urgently needs to be scaled up. Examples include pledges to multilateral climate funds (the Green Climate Fund and the Adaptation Fund); support channelled through the GCCA+ targeted at Least Developed Countries and Small Island Developing States; and the mobilisation of innovative financial instruments through the support to the preparation and financing of bankable climate-relevant development projects. EU Member States provided €4.8 billion in climate adaptation financing in 2019 and €6.7bn to cross cutting projects addressing both mitigation and adaptation, totalling over half of total Member States' Climate Finance.

Box 1: Stakeholder views on the main problems for the EU Adaptation strategy

Stakeholder views[99]:

In all consultation work streams, stakeholders expressed an interest in the EU providing consistent guidelines and indicators for monitoring and reporting on adaptation. For interviewees and workshop participants representing national and local authorities, civil society businesses and international organisations, ***the EU should play a key role in facilitating knowledge sharing at all levels of governance, between countries and within them****. The lack of effective mechanisms to support mainstreaming of ecosystem-based approaches was also mentioned multiple times by civil society representatives as well as some national authorities, international organisations, EU institutions and businesses. These stakeholders agreed that* ***the EU should promote the development of standard methodologies to quantify the costs and benefits of ecosystem-based approaches****, in order to help with the implementation of solutions. Other needs for guidance mentioned by businesses, international organisations and other stakeholders include guidance on adaptation planning, financing (investments), and monitoring. Overall, the role of the EU in*

https://data.consilium.europa.eu/doc/document/ST-5033-2020-INIT/en/pdf

[96] Ibid

[97] COACCH (2018). The Economic Cost of Climate Change in Europe: Synthesis Report on State of Knowledge and Key Research Gaps. Policy brief by the COACCH project. Editors: Paul Watkiss, Jenny Troeltzsch, Katriona McGlade. Published May , 2018. (pg. 56).

[98] Benzie, M., T. Carter, F. Groundstroem H. Carlsen, G. Savvidou, N. Pirttioja, R. Taylor & A. Dzebo (2017). Implications for the EU of cross-border climate change impacts, EU FP7 IMPRESSIONS Project Deliverable D3A.2.

[99] See Annex 2 for more details on the stakeholder consultation.

providing consistent guidance was reported by all stakeholder groups.

In the stakeholder workshops and targeted interviews, ***Member State "inertia" towards adaptation*** *was identified as a general barrier, particularly among international organisations and civil society representatives, though it was also reported by some national authorities, EU institutions and businesses representatives. As one representative of a European Business Association mentioned: "the Member States tend to be barriers to making progress on the issue themselves." More specifically, workshop participants and interviewees explained this inertia with the* ***lack of formal (legal) commitments for adaptation and clear political targets*** *(especially in comparison to mitigation), the* ***lack of mechanisms and indicators to monitor and report implementation****, and the* ***lack of alignment of standard practices****.* ***The lack of funding*** *was also identified by several stakeholders (representing business organisations, civil society, EU institutions, local authorities, national authorities and international organisations) as a barrier to adaptation in the EU, though it was highlighted that this is most likely not caused by a lack of availability, but rather differing priorities and commitments.*

What are the problem drivers?

The adaptation gap is already large, as identified in global and European assessment reports, and getting larger. This is due to impacts being increasingly prevalent and because science is pushing our understanding of impacts (e.g. on cascading impacts).

Multiple reports highlight the global state of unpreparedness (IPCC more broadly, but more specifically the United Nations Environment Programme report series of Adaptation Gap reports). Most worrying is the lack of preparation for possible tipping points in the climate dynamics. At EU level, the European Environment Agency has continually highlighted this issue in its adaptation reporting, most recently on urban adaptation. Continued construction on floodplains, the increased covering of soil surfaces by concrete or asphalt, the small amount of green spaces, and urban sprawl encroaching on wildfire and landslide prone areas are making European cities much more vulnerable to climate change. The EEA's latest report (October 2020, quoted in the Impact Assessment) gives the latest state of play on European climate change adaptation planning and action efforts at local level. While many local authorities have realised the importance of becoming resilient to climate change, progress in adaptation planning remains slow. Implementation of adaptation measures and the monitoring of the success of these actions are even slower. Measures currently put in place mostly focus on developing knowledge, awareness raising or policy developments. Implementation of actual physical or transformative adaptation solutions is far behind — such as developing more green spaces to reduce the impacts of heatwaves or adjusting sewerage systems to cope with flash flooding.

D1: Accelerating pace of climate change impacts

With record high temperatures in 2020 globally and across much of Europe, and with a clear message from climate models that temperatures will continue to increase, the urgency to adapt seems undeniable.[100,101] Although climate change mitigation may reduce, or even avoid,

[100] Copernicus Climate Change Service (2020) 2019 was the second warmest year and the last five years were the warmest on record. Retrieved from https://climate.copernicus.eu/copernicus-2019-was-second-warmest-year-and-last-five-years-were-warmest-record

some impacts of climate change in the EU[102], stopping all greenhouse gas emissions in the EU would not stop the climate impacts that are already occurring, and which are projected to continue to increase for decades (see Annex 9).

This reflects the message of the IPCC Special report that even in a best-case scenario of sustained emission limitations, and global warming limited to 1.5°C, there will be severe (and unequally distributed) stress on agri-food systems, infrastructure, ecosystems, natural capital and human health.[103,104] There are heavy economic, social, and environmental costs associated with inaction. The PESETA IV study found that "exposing the present economy to global warming of 3°C would result in an annual welfare loss of at least €175 billion" in Europe[105]. A recent Horizon 2020 COACCH project study estimated costs of inaction in Europe in 2050 to be close to €200 billion per year in a 4°C pathway, and more than €100 billion per year in a 2°C pathway, and the COACCH study generally estimate higher costs than PESETA as they also include socio-economic changes[106]. Moreover, conditions for vital ecosystems, which provide critical services for mitigation (e.g. carbon sinks) and adaptation (e.g. protection against floods, desertification, water and air purification) are worsening. Box **2** summarises the climate impacts for the EU in a scenario without additional climate change mitigation (warming of 3°C or more above pre-industrial temperature) and without additional adaptation measures:

Box 2: Foresight to 2100 on projected climate impacts – cost of non-action in Europe

People:

- An additional 15 million Europeans living in the proximity of woodland would be exposed to high-to extreme fire danger for at least 10 days/year.
- Each year nearly 300 million people would be exposed to deadly heatwaves, resulting in a 30-fold rise in deaths from extreme heat (90,000 annual deaths compared to around 3,000 each year today).
- Water resources availability would drop by up to 40% in southern regions of Europe and droughts would happen more frequently in most of southern and western Europe.
- Water scarcity and drought would increasingly affect agriculture, energy production and water supply in regions that already suffer from water stress.

Planet:

- The alpine tundra domain would contract by 84% and practically disappear in the Pyrenees. The natural climatic tree line would shift vertically up by up to 8 m/year.

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[101] WMO (2020) WMO confirms 2019 as second hottest year on record. Retrieved from https://public.wmo.int/en/media/press-release/wmo-confirms-2019-second-hottest-year-record

[102] Feyen L., Ciscar J.C., Gosling S., Ibarreta D., Soria A. (editors) (2020). Climate change impacts and adaptation in Europe. JRC PESETA IV final report. EUR 30180EN, Publications Office of the European Union, Luxembourg, ISBN 97

[103] IPCC, 2018: Global Warming of 1.5°C. Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways. Retrieved from: https://www.ipcc.ch/sr15/

[104] IPBES (2019): Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. S. Díaz, J. Settele, E. S. Brondízio E.S., H. T. Ngo, M. Guèze, J. Agard, A. Arneth, P. Balvanera, K. A. Brauman, S. H. M. Butchart, K. M. A. Chan, L. A. Garibaldi, K. Ichii, J. Liu, S. M. Subramanian, G. F. Midgley, P. Miloslavich, Z. Molnár, D. Obura, A. Pfaff, S. Polasky, A. Purvis, J. Razzaque, B. Reyers, R. Roy Chowdhury, Y. J. Shin, I. J. Visseren-Hamakers, K. J. Willis, and C. N. Zayas (eds.). IPBES secretariat, Bonn, Germany.

[105] Feyen L., Ciscar J.C., Gosling S., Ibarreta D., Soria A. (editors) (2020). Climate change impacts and adaptation in Europe. JRC PESETA IV final report. EUR 30180EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-76-18123-1, doi:10.2760/171121, JRC119178.

[106] Horizon 2020 project COACCH (2018). The Economic Cost of Climate Change in Europe: Synthesis Report on State of Knowledge and Key Research Gaps. Policy brief by the COACCH project. Editors: Paul Watkiss, Jenny Troeltzsch, Katriona McGlade. Published May , 2018. (pg. 56).

- Ecological domains would shift northwards, resulting in severe changes of the current ecosystems in Europe (e.g. Alpine, Boreal), and the development of Tropical ones.
- Wildfire and pest outbreaks in forests would become more frequent and severe, increasing biomass loss and carbon release.

Prosperity:

- In the absence of international market adjustments, with current crops and practices, yields would decline by more than 10% in southern Europe.
- Total drought losses would increase to nearly 45 €billion/year with 3°C warming in 2100 compared to 9 €billion/year at present.
- Almost half a million people would be exposed to river flooding each year, or nearly three times the number at present, and river flood losses would rise 6-fold in magnitude, reaching nearly 50 €billion/year with 3°C in 2100.
- Coastal flood losses would grow by two orders of magnitude and climb to 250 €billion/year in 2100, while 2.2 million people would be exposed per year to coastal inundation compared to 100,000 at present
- If 3°C global warming occurred in today's economy, annual welfare loss could represent approximately 0.5% of EU GDP, when considering only a limited set of climate impacts (river and coastal flooding, agriculture, droughts, energy supply, and windstorms). Furthermore, mortality from temperature extremes would also cause significant additional economic losses in the range of EUR 122 billion.

Source: JRC PESETA IV final report (2020)

D2: Knowledge gaps on climate change adaptation

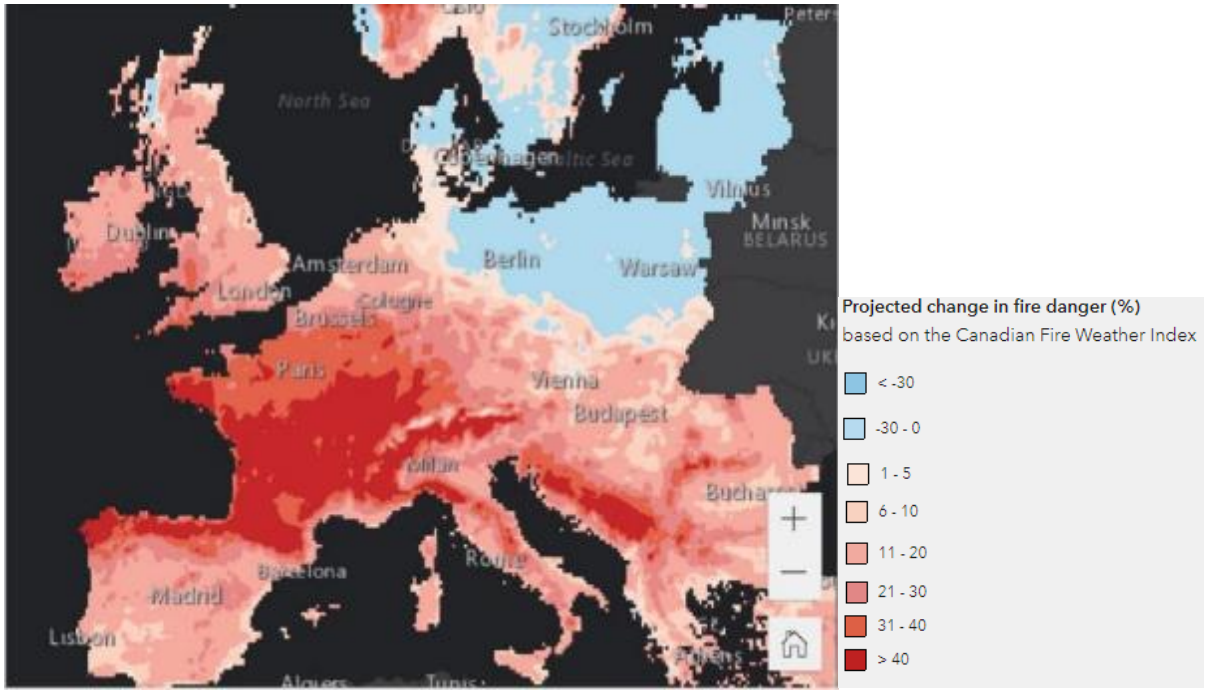
Uncertainty about climate change pathways is itself a barrier to adaptation action.[107] If we can better understand climate change impacts, and make that information widely available, people will take wise decisions and adapt. would need to mobilise additional support for e.g. the development of better economic models for the impacts of climate change, sectoral interlinkages, and their (economic and non-economic) cost, a deeper understanding of health and environmental impacts, including on ecosystem services, and foster innovative uses of climate data. There remain large knowledge gaps that would still need to be bridged, such as on economic losses from climate change, cascading effects from simultaneous or sequential climate impacts, spill-over effects from outside Europe on the EU, or tipping points beyond which the human and natural ecosystems would not recover. Moreover, the diverse information sources on climate impacts in Europe (e.g. European Forest Fires Information System, European Drought Observatory) and internationally need to be better federated to increase visibility and coverage, and to ensure compatibility of information.

There is increasing demand for translating the existing wealth of climate data and information into customised tools and products i.e. solutions. These tools are part of the backbone of the transition to a climate-resilient and low-carbon society, as they are needed to help decision-makers take informed decisions to boost resilience and adaptation capacity of their communities. More actions are needed to scale up local adaptation solutions through national and EU funding for regional development and innovation.

[107] Aguiar, F. C., et al. (2018) Adaptation to climate change at local level in Europe: an overview. Environmental Science & Policy 86: 38-63.

The uncertainty of losses and climate damage estimates, and the absence of sufficiently reliable predictive models, have impacts on the accurate pricing of insurance products; this creates a major barrier for private sector investments. This lack of knowledge also contributes to decision makers not taking decisions that place due value on climate resilience. Such tools exist (e.g. Figure 2 illustrates one developed by the EEA to improve knowledge of forest fire risks), but they are not precise enough to serve local administrations or private insurers.

Figure 2: Example of projected change in meteorological forest fire danger by the late 21st century compared with the period 1981-2010.



Source: EEA Story maps http://discomap.eea.europa.eu/climate

D3: Low public engagement and professional awareness

All levels of government, including cities and regions, need a **sound understanding of the climate risks and vulnerabilities on their territory** to guide their decision-making and policy shaping.[108] Therefore, in the implementation of the 2013 Strategy, efforts have been made towards a better understanding of risks and vulnerabilities throughout Europe. Public awareness is on the rise from directed policies (e.g. local awareness campaigns) and from daily news of climate-change related impacts such as extreme weather and forest fires. Seven in ten respondents to a 2019 special Eurobarometer[109] agreed that adapting to the adverse impacts of climate change could have positive outcomes for citizens in the EU.

There has been a significant increase in the knowledge base for vulnerability assessments since 2014, boosted by a number of EU-funded research (e.g. ESPON, PESETA); however, the assessments still vary significantly; and thus, so does the level of understanding of adaptation options to reduce vulnerability and risks.[110] To illustrate this, the 2018 EEA report on National climate change vulnerability and risk assessment[111] provided a

[108] European Commission Joint Research Centre (2018) Guidebook 'How to develop a Sustainable Energy and Climate Action Plan (SECAP)' Available at: https://publications.jrc.ec.europa.eu/repository/bitstream/JRC112986/jrc112986_kj-nb-29412-en-n.pdf
[109] Special Eurobarometer 490 https://ec.europa.eu/clima/citizens/support_en
[110] Ecofys (2017) Assessing Adaptation Knowledge in Europe: Vulnerability to Climate Change.
[111] EEA (2018) National climate change vulnerability and risk assessments in Europe

review of national climate change impact, vulnerability, and risk assessments (CCIV) across Europe. The evaluation showed that almost all EEA member countries have conducted at least one national CCIV, which was then used as a key information source for the development of national adaptation policies. The analysis, however, also noted challenges related to gaps in data, integration of quantitative and qualitative information, and cross-sector comparisons.

The European Green Deal mentions **that involvement and commitment of the public and of all stakeholders** is crucial to its success. For adaptation in particular, the distribution of roles and responsibilities between the European institutions, the Member States' governments, regional and local authorities, citizens and the private sector remains unclear. This is partly due to the cross-sectoral nature of adaptation.

Moreover, there are different approaches to stakeholder engagement in EU countries and different approaches to stakeholder engagement throughout the policy cycle: in the process of setting climate change adaptation goals, some countries engage stakeholders via consultation processes, whereas others provide on the ground technical adaptation support.[112] To differing extents in different countries, involving stakeholders in the process of developing adaptation strategies has increased awareness and acceptance, which ultimately helps successful implementation of a strategy. This is also closely related to the need for a multi-disciplinary understanding of climate change adaptation, which is recognised by local authorities and stakeholders as a way to avoid maladaptation. This often means fixing one single problem that creates bigger ones elsewhere e.g. the over-reliance on irrigation to continue growing crops no longer suited for the new local climate thereby exacerbating water shortages for other users. Likewise, some economic practices are no longer suitable under changing climate change conditions, like the exploitation of monoculture plantations of trees prone to fire (e.g. eucalyptus in Portugal or Spain). Despite these examples, the use of cross-sectoral approaches remains limited[113].

D4: Insufficient priority given to adaptation in some Member States and regions

Adapting to climate change is first about building resilience and anticipating the impacts, and ultimately reacting and managing impacts if/once they arrive. The Paris Agreement calls for a balance between adaptation and mitigation[114]; however, in the EU adaptation investment tends to have a lower priority than mitigation.[115] At the local level, cities have mostly dealt with mitigation and adaptation as two separate strategies. Local authorities that participate in networks are more likely to have started the adaptation process; being a member of multiple networks is associated with higher levels of adaptation planning, sharing of best practices, and receiving support in developing their Strategy.[116]

Policy tends to give greater priority to climate change mitigation[117], but this behaviour is also more widespread for the private and public sector, and citizens, constituting a significant obstacle to adaptation.[118] On the side of the private sector, we see that financial markets for adaptation are less developed than for mitigation. This preference might be motivated by

[112] Committee of the Regions (2016) Regional and Local Adaptation in the EU since the Adoption of the EU Adaptation Strategy in 2013
[113] https://www.eea.europa.eu/publications/national-adaptation-policy-processes
[114] UNFCCC (2015). Paris Agreement. Article 9, paragraph 4.
[115] FEPS and IEEP (Forthcoming). A Green Deal for All. Achieving sustainable equity between the people, regions, countries and generations of Europe, Foundation for European Progressive Studies and Institute for European Environmental Policy, Brussels, Belgium
[116] Heidrich, Oliver, et al (2016) National climate policies across Europe and their impacts on cities strategies. Journal of environmental management 168 (2016): 36-45.
[117] Ibid
[118] Adger, W. Neil, et al. (2013) Cultural dimensions of climate change impacts and adaptation. Nature climate change 3.2 : 112-117.

other perceived benefits of climate change mitigation measures. These include economic savings and improved energy security[119]; or by a belief that mitigation action is a common good better suited to public policy, while the benefits of climate change adaptation are largely related to private goods (e.g. climate proofing supply chains, flood protection for private residences), or that in some sectors a clear-cut separation between adaptation and mitigation is not evident.[120] In addition, the actual impact of adaptation measures is more difficult to measure than the effect of mitigation (i.e. GHG emissions reduction). Adaptation actions are most successful when there are no damages, and therefore less visible and attributable.

Choosing between adaptation and mitigation is, however, a false choice—we must do both.[121] Sustained emission limitations will decrease the medium-to-long term severity of climate impacts. An integrated approach of both mitigation and adaptation action, is therefore warranted. Moreover, adaptation requires as much attention as mitigation because even the most successful mitigation action (i.e. achieving globally a limited temperature increase of just 1.5°C) still comes with severe impacts to which we must adapt. One example of synergies between adaptation and mitigation is the implementation of Nature-based Solutions (NbS) – these can contribute to climate change mitigation through both storing and sequestering carbon and reducing energy demand (e.g. by improving thermal comfort in cities) and increasing water retention thus reducing the risk of flooding and recharging groundwater(see Annex 9), amongst other adaptation benefits.[122] In addition, prevention of climate related disasters, and reduction of their impacts as far as possible is more cost effective than dealing with the unmitigated consequence, for instance in terms of emergency response.

D5: Slow adoption and implementation of local adaptation strategies

The Evaluation found that **progress on local adaptation strategies has been slower than envisaged** in 2013.[123] This is evident in the relatively low number of cities working on adaptation compared to those committed to mitigation, for example based on the actions submitted to the Covenant of Mayors as of 2020, only 2% (almost 4,000 out of 175,120) are adaptation focused, the remaining being related to climate change mitigation.[124] Reasons for this slow up take include, among others, the lack of human and financial resources, especially in Southern Europe, whereas, in Northern Europe, uncertainty on climate change scenarios is seen as an important barrier. [125] For Eastern Europe, both the limited capacity in policy, practitioners and research communities and lack of political commitment were noteworthy.

Research has shown that how societies respond and adapt to climate change is influenced by culture, historical memory and identity[126], each of which can either improve awareness and sense of urgency for specific climate-related risks, or shift attention away from others.[127]

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[119] Reckien, D. et al. (2018). How are cities planning to respond to climate change? Assessment of local climate plans from 885 cities in the EU-28. Journal of Cleaner Production. 191. 207-219. 10.1016/j.jclepro.2018.03.220.
[120] Schneider, T. 2014. Responsibility for private sector adaptation to climate change. Ecology and Society 19(2): 8. http://dx.doi.org/10.5751/ES-06282-190208
[121] Global Commission on Adaptation (2019). Adapt now: A Global Call for Leadership on Climate Resilience. Retrieved from: https://reliefweb.int/sites/reliefweb.int/files/resources/GlobalCommission_Report_FINAL.pdf
[122] European Commission (forthcoming) Nature-based solutions- State of the art in the EU-Funded projects.
[123] European Commission (2018) Evaluation of the EU Strategy on adaptation to climate change, Report from the Commission to the European Parliament and the Council.
[124]Covenant of Mayors for Climate & Energy. Covenant in Figures. Retrieved 17.06.2020. https://www.covenantofmayors.eu/about/covenant-initiative/covenant-in-figures.html
[125] Aguiar, F. C., et al. (2018) Adaptation to climate change at local level in Europe: an overview. Environmental Science & Policy 86: 38-63.
[126] Marschütz, B. et al. (2020). Local narratives of change as an entry point for building urban climate resilience. Climate Risk Management, 100223.

D6: Insufficient public and private sector adaptation investment

Financial support for adaptation is not sufficient for the challenges we are facing. Based on estimates of the investment needed to meet adaptation needs, it can be assumed that there is a sizeable unmet finance need for climate resilient investments in Europe[128,129]. Competing policy and spending priorities, such as currently the COVID-19 response, and the unevenly distributed impacts of climate change and means to adjust across Member States, place a burden on the role of policy interventions and public finance to bridge the adaptation-finance gap.[130131] Investments being mobilised for the COVID-19 recovery through the Next Generation EU Fund and a reinforced long-term budget for the European Union provide an opportunity for investments in adaptation and resilience to be upgraded.[132] Moreover, the further strengthening in the next MFF of the EU's social dimension and European Social Fund (ESF+)[133] may give more support to the protection of the most vulnerable. Within the EU, the aim from the 2014-2020 MFF that at least 20% of European budget expenditure is climate-related, has been increased to 30% in the 2021-2027 MFF adopted in December 2020[134].

The European Green Deal emphasises the role of private investment alongside public investment, and reaffirms the importance of access to data and the development of instruments for investors, insurers and business to integrate climate change into their risk analyses.[135] Moreover, the Paris Agreement (Article 2.1(c)) establishes the core objective of "making finance flows consistent with a pathway towards low GHG emissions and climate-resilient development". In order to meet international climate goals, there is a collective challenge to "shift the trillions" in capital to help drive the transition to a zero carbon, climate-resilient economy. Public sources of finance will not be able to meet this demand on their own.[136] More and more Europeans are finding that solidarity is needed in the face of unpredictable disasters (both distinct and slow-onset), and governments are more suited for this than markets. Public funds continue to play the major role in prevention and resilience; however, private capital is required to mainstream resilience in private investment, including through climate proofing, and through risk pooling via private insurance.

Several general barriers exist for private sector financing of adaptation projects. [137] Firstly, adaptation does not typically generate a revenue stream and is therefore less attractive for private finance. Secondly, adaptation includes a range of wider benefits to society (in

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[127] Ibid

[128] Bottom-up Climate Adaptation Strategies Towards a Sustainable Europe (BASE) (2016) EU-wide economic evaluation of adaptation to climate change. Retrieved from: https://base-adaptation.eu/sites/default/files/D.6.3_1.pdf

[129] De Bruin, K. C., Dellink, R. B., & Agrawala, S. (2009). Economic aspects of adaptation to climate change: integrated assessment modelling of adaptation costs and benefits. (OECD environment working papers; No. no. 6). Paris: OECD. https://doi.org/10.1787/225282538105

[130] No estimations of the investment needs for adaptation exist that reflect the total, comprehensive (across all adaptation-relevant action areas and sectors) investment needs for Europe. A large range exists between the two main studies that are believed to best capture the adaptation investment needs in the EU , varying from €35 billion up to more than €500 billion

[131] De Bruin, K. C., Dellink, R. B., & Agrawala, S. (2009). Economic aspects of adaptation to climate change: integrated assessment modelling of adaptation costs and benefits. (OECD environment working papers; No. no. 6). Paris: OECD. https://doi.org/10.1787/225282538105

[132] European Commission (2020). Financing the Recovery Plan for Europe. Retrieved from:https://ec.europa.eu/info/sites/info/files/factsheet_3_04.06.pdf

[133] European Commission (2020). A new, stronger European Social Fund Plus. Retrieved from: https://ec.europa.eu/esf/main.jsp?catId=62&langId=en

[134] European Council press release, ''Long-term EU budget 2021-2027 and recovery package'', 17 December 2020 - https://www.consilium.europa.eu/en/press/press-releases/2020/12/17/multiannual-financial-framework-for-2021-2027-adopted/.

[135] Commission Work Programme 2020 (COM (2020)37 final).

[136] Climate Policy Initiative (2019). Measuring the Private Capital Response to Climate Change: a proposed dashboard. Retrieved from: https://climatepolicyinitiative.org/publication/measuring-the-private-capital-response-to-climate-change-a-proposed-dashboard/

[137] United Nations Environment Programme (UNEP) Finance Initiative (2016). Demystifying adaptation finance for the private sector. Nairobi: UNEP.

addition to the direct, private benefits of avoided damages, such as the recreational values for restored floodplains meant to protect private farms, biodiversity gains from green roofs meant to cool individual buildings etc.) that are not necessarily captured by the private financial return on investments (public good problem). Thirdly, many financial markets are characterised by a shortage of the longer-term credit that is necessary for long-term adaptation investments. Finally, reliable information on climate impacts on the economy is often unavailable or unequally distributed among different actors, who are often unaware. This disempowers actors from making informed decisions and investing accordingly.

D7: Lack of customised and cost-effective adaptation solutions

The 2018 evaluation concluded that there is a need to climate-proof investments supported by **research and innovation.** This need is reaffirmed by the Mission on "Adaptation to Climate Change, including Societal Transformation"; this is proposed under Horizon Europe, and employs innovation as a way to catalyse systemic change.[138] The proposed Mission would test integrated solutions to address the complex, multi-faceted nature of the transformation needed.

Moreover, recent research[139] shows the importance of a focus on innovation. The share of climate change adaptation inventions in 2015 was roughly the same as in 1995, and this stagnation stands in sharp contrast to the trend for climate change mitigation technologies, whose share in total innovation (including non-climate-related) nearly doubled during the same period. Moreover, few adaptation inventions are transferred across borders, and there is virtually no transfer of patented knowledge to low-income countries.

In particular, effective mechanisms to support mainstreaming of NbS are missing. Despite the fact that NbS have proved to be cost-efficient policy approaches to address climate change adaptation, they are yet not used on a large enough scale.[140] Reasons for this relatively low uptake are multiple (e.g. cultural perceptions, knowledge and awareness gaps, lack of guidance), and have driven to, among others, unevenness of climate change adaptation action across Member States. In addition to this, even though interest in the NbS concept is increasing in different areas, it has mainly been applied in the agriculture and forestry sectors, for which NbS are at the same time also contributing to mitigation. Experts continue to advocate for supporting legislation that enables its systematic mainstreaming into urban planning, i.e., incorporating its principles (e.g. multi-benefit, sustainability) into relevant policies and planning tools across sectors.[141]

Finally, the lack of accurate models, data and knowledge on damages and losses means that climate impacts are not being priced in private decision making, particularly by SMEs as they often lack the capacity to do so. Currently, climate-related events such as drought, hail, and extreme heat are often not insurable. The insurance policies that are available cannot adequately cover the increasing risks SMEs face. This affects the availability of cost-effective solutions and skills.

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[138] DG Research and Innovation (September 2020). Proposed Mission: A Climate Resilient Europe. Retrieved from: https://ec.europa.eu/info/publications/climate-resilient-europe_en

[139] Dechezlepretre,Antoine; Fankhauser,Sam; Glachant,Matthieu Michel Marcel; Stoever,Jana; Touboul,Simon.2020. Invention and Global Diffusion of Technologies for Climate Change Adaptation: A Patent Analysis (English). Washington, D.C.: World Bank Group.https://documents.worldbank.org/en/publication/documents-reports/documentdetail/648341591630145546/invention-and-global-diffusion-of-technologies-for-climate-change-adaptation-a-patent-analysis

[140] European Commission (2019). Review of Progress on the Implementation of the EU Green Infrastructure Strategy. SWD (2019) 184 final. Retrieved from: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52019DC0236&qid=1562053537296

[141] Pauleit, S. et. al (2017). Nature-based solutions and climate change–four shades of green. In Nature-Based Solutions to Climate Change Adaptation in Urban Areas (pp. 29-49). Springer, Cham.

D8: International policy developments

Several important international agreements were adopted after the 2013 Strategy, including the Paris Agreement, the UN Sustainable Development Goals (in particular SDG 13 on climate action, SDG 11 on sustainable and resilient cities, but also others)[142], the Sendai Framework for Disaster Risk Reduction 2015-2030 and the EU Sendai Action plan[143]. These developments in international policy increased the need to harmonise and closely integrate the EU strategy with international climate change adaptation issues.

D9: Climate impacts increasingly generate spillover effects across the globe

The **2013 Strategy does not sufficiently recognise and address the EU's vulnerabilities to international spillover effects from climate change impacts outside Europe**[144]. Globally, climate change has the potential to affect trade, food security, stability and security, and biodiversity. In terms of trade, risks extend along supply chains. What occurs outside Europe due to a changing climate will affect the production and transport of raw materials and intermediate goods[145]. In fact, indirect impact of effects of climate change internationally could be as large as the direct impacts within Europe. Imports from non-EU regions could decline by 2% by 2050, while exports to non-EU regions could also decline by up to 0.3%[146]. An EEA 2016 report[147] details Europe's vulnerabilities from international spillover effects related to food production and supply, including economic effects through climate-induced price volatilities, and disruptions to transport networks and changes to shipping routes. The COACCH project found that the EU - due to the single market and stronger export orientation – receives more supply chains shocks from abroad than the USA. The effects are largest for manufacturing and agriculture[148].

Box 3: Stakeholder views on problems drivers hindering the new EU Adaptation Strategy

Stakeholder views[149]:

Impacts: *Most of the respondents to the open public consultation (OPC) considered that the* ***growing speed of climate impacts*** *is a "very important" driver for the new EU Adaptation Strategy (75.5%).[150] An important difference between OPC respondents' reports of most-experienced events and those of contributors to other consultation activities was their appreciation of water-related events. While OPC respondents seem to have experienced these climate-related events less than other events, the majority of workshop participants and interviewees from all stakeholder groups (including civil society, national authorities, EU institutions and international organisations) referred to coastal erosion, flooding, saltwater*

[142] https://sustainabledevelopment.un.org/
[143] Commission Staff Working Document: Action Plan on the Sendai Framework for Disaster Risk Reduction 2015-2030, SWD (2016) 205 final/2.
[144] Commission Staff Working Document (2018) Evaluation of the EU Strategy on adaptation to climate change Accompanying the document Report From The Commission To The European Parliament And The Council on the implementation of the EU Strategy on adaptation to climate change SWD/2018/461 final
[145] Lühr, Oliver, Dr Jan-Philipp Kramer, Jannis Lambert, Christian Kind, and Jonas Savelsberg. 2014. 'Analyse spezifischer Risiken des Klimawandels und Erarbeitung von Handlungsempfehlungen für exponierte industrielle Produktion in Deutschland (KLIMACHECK)'. Studie im Auftrag des Bundesministeriums für Wirtschaft und Energie Bearbeitungsnr.: I C 4 –02 08 15 – 30/12. Berlin: Prognos / adelphi.
[146] COACCH (2018). The Economic Cost of Climate Change in Europe: Synthesis Report on State of Knowledge and Key Research Gaps. Policy brief by the COACCH project. Editors: Paul Watkiss, Jenny Troeltzsch, Katriona McGlade. Published May , 2018.
[147] 'Climate change, impacts and vulnerability in Europe 2016, Report No 1/2017', European Environment Agency, 2017: Chapter 6.4
[148] COACCH (2019). The Economic Cost of Climate Change in Europe: Synthesis Report on Interim Results. I_O Analysis by Stefan Borsky, Martin Jury. Policy brief by the COACCH project. Editors: Paul Watkiss, Jenny Troeltzsch, Katriona McGlade, Michelle Watkiss.
[149] See Annex 2 for more details on the stakeholder consultation.
[150] See Figure 3-11 in Appendix 1.A accompanying the consultation synopsis presenting the analysis of the OPC.

intrusion and lack of water availability as some of the most important slow-onset changes caused by climate change in Europe. This was due to the substantial proportion of the EU population which is coastal (including in the outermost regions), and the importance of water availability for agriculture. River flooding was mentioned by workshop participants representing national authorities and interviewees representing civil society organisations as another important security concern for the large share of the population living close to rivers. They also highlighted strong differences in vulnerabilities across Europe. Southern Europe and Mediterranean regions were reported as the most vulnerable regions by the majority of respondents across all stakeholder groups, though Central and Eastern Europe were considered increasingly vulnerable.

***Problem drivers**: OPC respondents identified the following factors as important for the design of the new Strategy: a **lack of interest** in climate impacts in some Member States or regions (57.7%); **insufficient public finance** for adaptation to climate change (55.2%); **insufficient public awareness** of the need to adapt to climate change (51.4%); and **low private sector investment** and action on adaptation (44.4%). In both the OPC, stakeholder workshops and interviews, the **lack of knowledge and awareness** was reported as key problem driver by all stakeholder groups. According to them, at the policy-making level, the lack of knowledge and awareness on climate change adaptation most likely stems from a **lack of access to available and usable knowledge and data**. Stakeholders from EU institutions, government authorities and international organisations have highlighted the difference between access and usability of data as a problem driver as opposed to lack of data, pointing that sufficient data currently exists. In the stakeholder workshops, several participants across various stakeholder groups agreed on the lack of awareness at the citizens' level, which manifests itself as a **lack of information on the cost** of inaction and unpreparedness and prevents a necessary behavioural change.*

3. WHY SHOULD THE EU ACT?

Legal basis

The various legal bases for the Adaptation Strategy are addressed in the 2013 EU Adaptation Strategy and include at the highest level the Treaty on the Functioning of the European Union (TFEU Articles 191 and 192(1)). The Commission proposal for a European Climate Law Regulation also contains provisions on adaptation to climate change. Furthermore, the Paris Agreement constitutes an additional international legal basis on which the Union can anchor its efforts in climate change adaptation. A full overview of the legal base is in Annex 8.

Subsidiarity: Necessity and Added Value of EU action

According to the principle of subsidiarity, the new EU Adaptation Strategy must be necessary, and bring added value in comparison to individual actions from the Member States alone. The EU was an early actor on adaptation, and the European Commission was recognised by the Global Commission on Adaptation[151], as a pioneer in integrating considerations of climate risk into decision-making. An ambitious and more proactive EU-level intervention is warranted.

The consultation undertaken as part of the 2018 Evaluation indicated that, although governments at different levels would have independently worked on adaptation, progress

[151] https://gca.org/global-commission-on-adaptation/report

would have been much less significant in the absence of the EU Strategy. Moreover, the current Strategy brings EU added value by, e.g. encouraging the identification and bridging of knowledge gaps in research, supporting regional cooperation, and by integrating adaptation in its own policies. The EEA has demonstrated the added value of adaptation action at EU level with the example of Climate-ADAPT[152].

As much as individual cities and regions must take action to become more resilient to global warming, the Union as a whole must take steps to prepare itself better. For optimal adaptation in the Union, all levels of government have to contribute, including EU, national, regional and local. Moreover, there is increasing clarity that civil society and individuals have an important role to play, and EU level action can help empower them in their actions (e.g. through the Climate Pact). EU action also can significantly enhance local and regional adaptation action, for instance through geospatial information and modelling (e.g. the EU Copernicus programme) or EU and international exchanges of best practices, e.g. via the European and Global Covenants of Mayors.

Even if adaptation challenges are often local and specific (a strong argument for local-level adaptation policy), solutions are just as often widely applicable on a regional, national or transnational scale. Moreover, there are also EU-specific impacts (e.g. threats to the Single Market, effects on EU budget, on trade deals, additional pressure on migratory flows, the spread of infectious diseases and plant pests) or regions with specific vulnerabilities (e.g. EU's nine outermost regions in the Atlantic and Indian Oceans as well as Mediterranean countries).

The compatibility and added value of the EU Adaptation strategy with the principle of subsidiarity are underpinned by:

- Shared vulnerable assets: The Strategy addresses areas of shared competence, including challenges that pertain to transnational governance such as the management of water catchments, civil protection, biodiversity, and marine and terrestrial ecosystems-based services (COM (2020)/2509310).
- Transboundary impacts: Climate change impacts occur irrespective of administrative boundaries. There is a strong cross-border dimension of many climate change impacts (EU macro-regions sharing common climate risks, e.g. seas and river basins and Alpine mountainous areas). Lack of preparedness in one Member States may have negative consequences for the other Member States. The Covid-19 outbreak, which started in a region to later escalate into a global crisis, illustrates the economic and social interconnectedness between countries, demonstrating the benefits of coordinated action at EU level.
- Shared solutions: The EU can identify and promote transboundary solutions through its existing instruments, actions and policies in transnational sectors and regions[153] at risk, such as the CAP, the Biodiversity Strategy etc. It can also identify regional knowledge gaps, harmonise tools and facilitate science-policy interactions to foster mutual learning across the Member States and systematise information for decision-makers.

Finally, solidarity and convergence across and within the Member States and ensuring a just transition (as well as a just resilience to climate change), have a key role to play for

[152] https://www.eea.europa.eu/publications/sharing-adaptation-information-across-europe
[153] https://www.eea.europa.eu/themes/climate-change-adaptation/adaptation-policies/adaptation-policies-in-transnational-regions

adaptation as highlighted in the European Green Deal and the Commission proposal for a European Climate Law.[154]

4. OBJECTIVES: WHAT IS TO BE ACHIEVED?

General objective

Adaptation is about understanding, planning and acting to prevent the impacts in the first place, minimise their effects, and address their consequences. Against all the gloom of climate impacts and the inevitability of certain shocks, the benefits of adaptation actions extend beyond the avoided human, natural and material losses. They have many positive and significant socio-economic effects, with high cost-benefit ratios:

- environmental and social benefits accompany many adaptation actions (e.g. nature-based solutions for flooding that also clean the air and waters and restore habitats to support biodiversity);
- reducing climate impacts on vulnerable groups and countries enhances social cohesion;
- adaptation actions targeting better management of natural resources can reduce tensions between communities and support conflict prevention efforts;
- effective adaptation helps secure EU strategic autonomy (as it provides the stability required to progress on emission reductions, security, migration, sustainability);
- enhanced financial and budgetary stability, and economic growth (as it reduces vulnerability to climate-related macroeconomic shocks and pay-outs after disasters);
- avert, minimise and address population displacement associated with the adverse effects of climate change;
- competitiveness in the growing global adaptation industry (a market worth ~EUR 280 billion in 2016, growing at ~6% per year);
- increased resilience and sustainability in EU firms' operations and supply chains;
- a sense of empowerment to citizens, by demonstrating that preventing and managing climate impacts can be achieved, and that they can be engaged in it.

In order to tackle the problems identified in Section 2, it is important to clarify the objectives of EU action in the field of climate change adaptation. Therefore, this section presents the overarching objective of the new EU Adaptation Strategy: "*By 2050, the Union will be a climate-resilient society, fully adapted to the unavoidable impacts of climate change, with reinforced adaptive capacity and minimal vulnerability, and that contributes to achieving the Paris Agreement global goal on adaptation*."

This objective builds on the 2013 Strategy's objective, which is "to contribute to a more climate-resilient Europe" by enhancing the preparedness and capacity to respond to the impacts of climate change at the local, regional, national and EU levels, developing a coherent approach and improving coordination. [155] It is fully aligned with the Commission

[154] Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL establishing the framework for achieving climate neutrality and amending Regulation (EU) 2018/1999 (European Climate Law) COM/2020/80 final

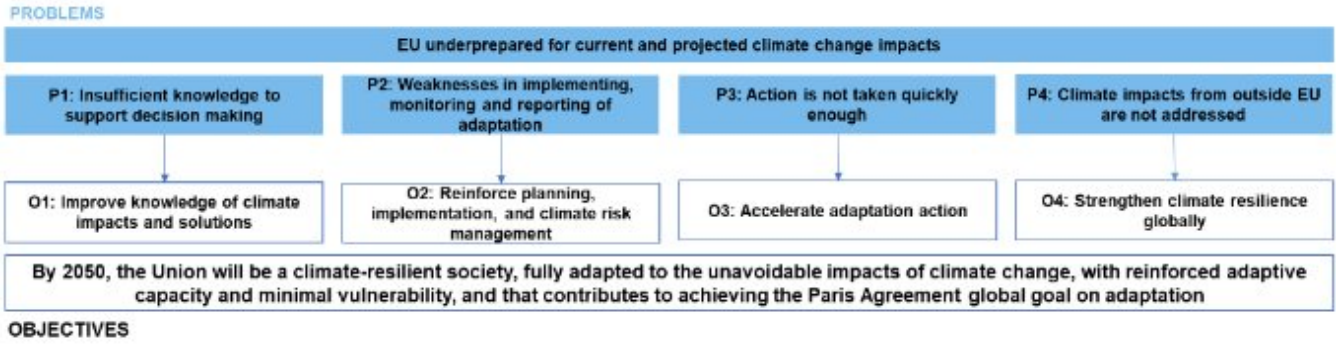
[155] European Commission (2013) An EU Strategy on adaptation to climate change, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions COM/2013/0216 final, available at - https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52013DC0216

proposal for a Climate Law, which sets Europe on a path towards the global adaptation goal (Article 7 of the Paris Agreement) [156]. The current objective is more ambitious than the 2013 objective, as it sets out a vision for Europe towards 2050 to become a climate-resilient society and goes beyond a contribution to resilience. Moreover, it includes a *strengthened international dimension*, as per the problem definition. The specific objectives also incorporate a novel, mainstreamed citizen-dimension, similarly identified in, and supported by, the stakeholder consultation.

Specific objectives

In order to achieve this general objective, four specific objectives are identified which correspond to each of the problems discussed in section 2.1. The relationship between the objectives and problems is presented in Figure 3. Objectives 1 to 3 aim to help actors at all levels to **improve their knowledge** of climate impacts, **reinforce planning** and climate risk management and to **accelerate adaptation action.** Objective 4 targets an increase in the **EU's contribution to global climate resilience**.

Figure 3: Objective tree for EU Adaptation Strategy



Objective 1 (O1) - Improve knowledge of climate impacts and development of solutions:
The new Strategy will aim to increase awareness, education and access to knowledge and fit-for purpose data on individual and collective climate risks, it will seek to develop innovative solutions, and the dissemination of good practice to improve decision making.

O1 addresses the need for **investment in frameworks, models and tools to support decision making within uncertainty**. Efforts to do so are reflected in the ongoing study of the European Commission (DG CLIMA) on adaptation modelling. [157] Adaptation modelling aims ultimately to act as a tool to guide innovation of adaptation solutions within the new Strategy.

The objective aims to step up ambition on improving knowledge and to invest in an (updated) **EU risk and vulnerability assessment, including in the outermost regions**. This action is in line with the 2018 Evaluation, which concludes that the knowledge gaps remain. The objective also increases ambition through the **establishment of valuation methodologies for climate change adaptation benefits and effectiveness of measures,** with a focus on NbS.

[156] Proposal for a European Climate Law COM/2020/80 final Explanatory Memorandum: "The proposal aims to complement the existing policy framework by setting the long-term direction of travel and enshrining the 2050 climate-neutrality objective in EU law, enhancing adaptation efforts, establishing a process to set out and review a trajectory until 2050, regular assessment and a process in case of insufficient progress or inconsistencies."
[157]European Commission DG Climate Action A.3. (2020). Study on Climate Modelling. Task 2 Comprehensive Desk Review: Climate Adaptation Models and Tools. Final draft report.

The objective increases the focus on **newly identified knowledge gaps** related to interdependencies, synergies with other relevant goals (e.g. biodiversity, mitigation). It will also focus on **research and innovation-inspired activities** to help deliver large-scale solutions for climate change adaptation as foreseen under the **Mission on "Adaptation to Climate Change, including Societal Transformation"** (and similarly in the Soil, Starfish 2030, and Climate-Neutral and Smart Cities missions), which is part of the upcoming EU Research and Innovation Framework Programme, Horizon Europe (2021-2027).[158] The Strategy will guide research under Horizon Europe (including in relevant Partnerships) with the aim to encourage greater uptake of innovation, and achieve positive economic impact and job creation for the pandemic recovery. Copernicus Climate Change Services will also continue to play a key role.

Objective 2 (O2) – Reinforce planning, implementation, and climate risk management: through risk assessments and management, and through helping to close the climate protection[159] gap via risk-transfer mechanisms.

There is a **continued need to strengthen mainstreaming of climate change adaptation across all sectors** at EU level. The Strategy will therefore focus on increased mainstreaming within EU funds, research and innovation, and key vulnerable sectors, such as coastal protection, energy infrastructure, agriculture, forestry, biodiversity, spatial planning, transport and communication, urban development, public health, and water. Moreover, it will focus on strengthening synergies and coherence with policies that share similar or interrelated objectives, like disaster risk reduction and civil protection.

The Strategy will also include a reinforced focus on **resilience of insurance and financial markets.** Even though the 2013 Strategy aimed to improve the market penetration of natural disaster insurance and to unleash insurance pricing for risk awareness prevention, measures need to be scaled up. Another important aspect of risk management includes closing the **climate protection gap,** which has been defined as the difference between the insured losses and the total economic losses caused by an extreme weather or climate-related event.[160]

Regarding financial markets in a broader sense, the new Strategy will increase efforts to **'build the business case for adaptation'**. This includes EU project finance and support to the development of methodologies to quantify the costs and benefits of resilient investments, and to facilitate integrating climate risk management in the full policy cycle.

Objective 3 (O3) – Accelerate adaptation action: with a focus on solutions (in addition to understanding), by deploying innovation (in addition to research), implementation (in addition to planning) and prevention (in addition to ex-post solutions).

The new Strategy needs to focus particularly on **accelerating action at the local level**. The continuing need for this remains clear in light of recent evidence that the impacts of climate change are already being felt across cities and rural areas in Europe.[161] The European Green Deal emphasises that, under the new EU Adaptation Strategy, **cities and regions should be able to access data and to develop instruments to integrate climate change into their risk management practices**. There is a need for strengthened support of knowledge sharing and

[158] DG Research and Innovation (September 2020). Proposed Mission: A Climate Resilient Europe. Retrieved from: https://ec.europa.eu/info/publications/climate-resilient-europe_en
[159] https://www.epc.eu/en/publications/Adapting-to-change~2fce48
[160] EIOPA (2019). Protection gap for natural catastrophes. Staff discussion paper. Retrieved from: https://register.eiopa.europa.eu/Publications/EIOPA-19-485_EIOPA%20Staff_Discussion_Paper_Protection_Gap.pdf
[161] EEA (2020). Urban Adaptation in Europe: how cities and towns respond to climate change. https://www.eea.europa.eu/publications/urban-adaptation-in-europe

capacity building as well as (access to) financial support, tailored to the local level. The role of peer-to-peer learning and the access to usable data for local governments are important elements of strengthening local action under the Strategy. The local capacity building anchored in latest science and innovation, and based on user-friendly, fit for purpose tools, services and solutions will also be a the centre of the Horizon Europe Mission on Adaptation to Climate Change, including Societal Transformation.

The need to adapt (critical) infrastructure to the impacts of climate change will have increased attention in the new Strategy, e.g. through **Nature-based Solutions and digital technology**.

Objective 4 (O4) – Strengthen global action for climate change adaptation and resilience: strengthening cooperation on enhancing action on climate change adaptation is necessary in order to make progress towards the global goal on adaptation enshrined in the Paris Agreement, and in line with other international commitments including the SDGs.

This will be achieved by assisting partner countries in adaptation planning processes and the implementation of actions, promoting comprehensive risk management approaches, scaling up and enhancing the effectiveness of support, and sharing information, good practices, experiences and lessons learnt (e.g. through Climate-ADAPT).

The new Strategy will provide a **framework to support the EU's partner countries in stepping up climate change adaptation and resilience**. Developing countries are particularly vulnerable to the impacts of climate change and have the least capacity to adapt.[162] **Additional and better-targeted financial resources** for climate change adaptation are thus urgently needed, both from domestic and international public sources, as well as from the private sector and innovative sources of finance.

The new Strategy will also address shared **challenges of interconnected economies** (e.g. supply chains**,** or risk assessing cascading climate impacts). At the same time, the EU can **learn** from others: many of the EU's international partners have long been on the frontlines of climate change and have valuable experiences that could help European communities become more resilient, for example on the topic of early warning systems and preparedness.

In addition, the objective contributes to:

- **Improved governance**: alignment and integration of regional, national and sub-national policy frameworks, with a specific focus on local authorities.
- **Gender-responsive planning, implementation,** and leveraging on local and indigenous knowledge and expertise.

Box 4: Stakeholder views on objective setting for the new EU Adaptation Strategy

Stakeholders views on specific objectives[163]:

According to expert interviewees and the majority of workshop participants from all stakeholder groups (including international organisation, civil society, businesses and one EU institution), ***the better use of data was considered an important objective of the new Strategy.*** *Stakeholders explained that, even though a lot of data is available, this could be perceived as an overload by Member States and local governments. This echoes respondents' identification of problems and drivers in the OPC, according to which knowledge and solutions are already*

[162] United Nations Environment Programme (UNEP) (2016). The Adaptation Finance Gap Report 2016. Nairobi: UNEP
[163] See Annex 2 for more details on the stakeholder consultation.

available to adapt to climate change, and that the focus should move from planning to action and addressing issues such as the need for financing.

Stakeholders also agreed that, in addition to funding support, ***the EU should promote the development of standard methodologies to quantify the costs and benefits of ecosystem-based approaches, in order to help with the implementation of solutions****. This was particularly mentioned across Member States and business representatives, but also reported by a few experts from civil society. Stakeholders from most stakeholder groups (EU institutions, national authorities, local authorities, international organisations and civil society) also suggested the Strategy could support a dedicated mechanism to provide tailored adaptation guidance and peer-to-peer knowledge sharing for local public authorities and non-state actors. Moreover, they mentioned a need for the Strategy to encourage cross-sector cooperation for the best solutions.*

Although planning needs to be reinforced, ***most participants of the OPC strongly agreed that an increased focus on implementation (in addition to planning) is needed (74.9%)****.*[164] *Respondents of the OPC strongly agreed that the EU should support Member State level action on adaptation (59.3%).*[165] *EU support at the local level also received strong support from all stakeholders. In the stakeholder consultations, there was an endorsement of continued support for action at Member State level, with a focus on supporting and ensuring proper implementation of national strategies. This was endorsed by national authorities, EU institutions representatives, international organisations and civil society organisations alike. In addition, in the stakeholder workshops and interviews, the majority of participants highlighted the importance of supporting adaptation at the local level, including by local authorities. This was emphasised by all stakeholder groups but particularly among civil society organisations and several Member States' representatives. As one stakeholder from a national government institution explained, support at the national and local level should go beyond EU leaflets. The majority of stakeholders also agreed in the workshops on faster deployment of solutions. One Member State representative suggested that this needs to come not only via Horizon Europe, but action should be scaled up at all levels.*

Overall, the lack of an international dimension of the 2013 Strategy was identified as a deficiency in all stakeholder consultations. *According to OPC respondents, it is most important for the new Strategy to be aligned with the global goal on adaptation as expressed in the Paris Agreement (71.8%*[166]*). This was most highlighted by international organisations, Member States' representatives, academic and research institutions, non-governmental organisations and EU institutions, and less so by citizens and business representatives. The importance of Paris Agreement alignment has also been mentioned throughout the stakeholder workshops and interviews.*

5. WHAT ARE THE AVAILABLE POLICY OPTIONS?

This section describes policy options, and the corresponding actions and measures, considered for inclusion in the new Strategy. The two **policy options** under consideration represent an umbrella for various actions and measures and form the main level at which the Impact Assessment will take place. The **actions** represent the main activities that would potentially take place under each option and are based on the structure of the 2013 Strategy

[164] See Figure 3-13 in Appendix 1.A accompanying the consultation synopsis presenting the analysis of the OPC.
[165] See Figure 3-14 in Appendix 1.A accompanying the consultation synopsis presenting the analysis of the OPC.
[166] See Figure 3-10 in Appendix 1.A accompanying the consultation synopsis presenting the analysis of the OPC.

and its eight actions (see Table 5 below). While Option 1 expands on the actions of the 2013 Strategy, new ones are proposed under Option 2. The **measures** are the specific, tangible steps that will be put in place to implement the actions. They are the measure of the choices for this Impact assessment in terms of ambition.

While many of the measures are not of a legislative nature, several notable examples will be pursued with separate legislative action. Climate proofing should be integrated in the Strategic Environmental Assessment. The collection of climate-related loss data from (re)insurers would be explored also in a legislative context (through the possible revision of the legal base of the European Insurance and Occupational Pensions Authority Regulation and/or the Solvency 2 directive). In order to be able to count on a truly EU climate insurance pool, the integration of a "build back better" requirement in the Solidarity Fund would require a revision of its legal base. In addition, several upcoming reviews (e.g. Urban Waste Water Treatment Directive) could see adaptation mainstreaming reinforced. For other processes, legislative follow up was not deemed necessary at this stage (e.g. there will be no revision of the Water Framework Directive following its fitness check, so climate change adaptation will be reinforced via guidance for the Common Implementation Strategy). Further work will require a pre-legislative follow up, such as white papers or blueprints, but also pilots of initiative (e.g. trying out with the Digital Europe Programme a pilot on loss data collection before rolling it out in legislation).

Ultimate success of the Strategy would mean a succession of positive assessments of progress towards increased climate resilience at Union level. The Paris Agreement global goal on adaptation is similarly a dynamic one (i.e. enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change). Dealing with climate impacts means dealing with complexity, uncertainty, tipping points, cascading risk – adaptation to these impacts therefore requires a dynamic implementation (i.e. not just one script to follow but multiple). As for any policy of disaster risk management (e.g. pandemics, earthquakes), success of adaptation action is often invisible because it constitutes averted damage (a counterfactual is difficult to construct).

Actions and measures were identified from a variety of sources; the 2018 Evaluation of the Strategy was nevertheless a key source, as it provided a detailed set of recommendations for measures in a revised Strategy. In addition, desk review, feedback from stakeholders through the Open Public Consultation, expert interviews and stakeholder workshops were all considered and contributed to the list of actions and measures proposed. The new strategy will indicate a vision for EU climate resilience and pursue it both directly, through the identified measures, and indirectly, through the principles it puts forward. This increased attention and strategic guidance will help bring existing instruments in line with the new reality of climate impacts (and add further justification for some instruments). It will also guide EU funding instruments (e.g. in the context of the 37% target for Recovery and Resilience Facility, or in programming for NDICI, CAP, Horizon Europe etc.) in terms of highlighting adaptation vs other policy priorities. In this regard, the strategy comes at an opportune moment because of priority setting and programming for the next MFF. Moreover, adaptation is most effective when it builds on the multiple benefits it can deliver (e.g. flood plain restoration as an opportunity to decrease flood impacts but also add recreation value, help biodiversity, reduce pollution etc.).

In this section we present, for each policy option, a selection of measures for which more detailed mini-assessments are carried out. Detailed descriptions of the measures can also be found in the annexes: Annex 7 for the measures selected for the mini-assessments contributing to the Impact Assessment in chapter 6, and Annex 6 for the other measures.

The selection of measures for mini-assessment was made in order to concentrate on the measures with the highest estimated direct impact relevant for Better Regulation (i.e. economic, social and environmental). The selection was based on a screening which considered the types of impacts each measure could have, the measurability of those impacts and the availability of evidence on them, whether the measures would impose significant costs on stakeholders, and the balance of measures across the actions. In this way a broad range of measures that are likely to provide the most relevant and assessable economic, social and environmental impacts were selected, with particular attention to those which may impose costs on stakeholders, raise political problems or encounter resistance in implementation.

What is the baseline against which the options are assessed?

Consistent with the Better Regulation Toolbox (#12, #17), the baseline option represents a 'no policy change' scenario (i.e. a policy baseline). This is taken as a continuation of the 2013 Adaptation Strategy in its current form, the 8 actions of which are presented in Table 5 below – a full assessment of this baseline option is available in the Evaluation of the 2013 Strategy.

The Union could continue with the current strategy, as its evaluation was positive, including on continue relevance, but would operate in an increasingly changing context (see Section 1) to which it is not equipped to respond. Changes in the international and EU context would continue to erode the relevance of the few actions not yet concluded in their original ambition.

Climate change impacts, and our understanding of them, have themselves evolved since the 2013 Strategy; the updated starting point and understanding of the impacts is an important part of the baseline, which draws on various IPCC reports and other authoritative source as well as recent research, including PESETA IV, Horizon 2020 COACCH project and the Study on Adaptation Modelling[167].

Furthermore, the COVID-19 crisis is having very significant impacts across the EU, and therefore both the crisis, and the policy response to it, will have impacts on the baseline scenario. There are two main ways in which this occurs: (1) the Recovery Fund will bring a large new source of EU investment, with a number of priorities announced that can influence adaptation, including through Horizon Europe and actions on climate change mitigation, which should reduce future climate impacts; and, (2) it increases attention on resilience, particularly in the area of health, but also more broadly, which should give the actions of the 2013 Strategy more traction. These changes will also be considered in the baseline to the extent possible, but it should be noted that, as many details remain to be finalised through the legislative process, and the proposals are quite recent, there is limited information, particularly quantitative information, on which to base an assessment.

Table 5: Baseline option – Actions

ACTION
1. Encourage all Member States to adopt comprehensive adaptation strategies
2. Provide LIFE funding to support capacity building and step up adaptation action in Europe (2014-2020)
3. Introduce adaptation in the Covenant of Mayors framework (2013/2014)

[167] Forthcoming 2021

ACTION
4. Bridge the knowledge gap
5. Further develop Climate-ADAPT as the 'first-stop shop' for adaptation information in Europe
6. Facilitate the climate proofing of the Common Agricultural Policy, Cohesion Policy and Common Fisheries Policy
7. Ensuring more resilient infrastructure
8. Promote insurance and other financial products for resilient investment and business decisions

Option 1: Deepening of existing actions of the 2013 Strategy

Based on the thorough Evaluation and extensive stakeholder feedback both as part of that Evaluation and in the design of the new Strategy, this option proposes ambitious changes to both the form and nature of the eight actions of the 2013 Strategy. It also provides a wide range of new measures to deepen their impact.

Table 6 lists the selected measures for which more detailed mini-assessments have been carried out (Annex 7). The full list of measures included in this option is presented in Annex 6. This option represents a clear step up in ambition, with commensurate increases in visibility and effectiveness for EU-level action while remaining well within the policy space of the 2013 Strategy. The relevance at action level is much increased compared to the baseline option, ensuring that the new Strategy would be adequately equipped to deal with the many of the domestic and international developments since 2013. It also proposes novel measures, which raise ambition compared to those in the baseline. This option could also help meet (albeit to a limited extent) the international objective (O4).

Table 6: Deepening of existing actions and their connectivity to the Drivers (D), Problems (P) and Objectives (O)[168]

ACTION	MEASURE	LINKING TO*
1. Closing further gaps in adaptation-relevant knowledge, through systematic data collection and sharing, and working with key public and private partners.	**1.5:** Close the climate disaster loss and risk data gap through (1) facilitating the recording, collecting and sharing of loss data from public and private sources through standards (2) establishing a climate risk data governance framework and ensuring open access to data, (3) collecting data on direct economic losses, non-economic losses and slow-onset events, and aligning existing programmes and data sources.	**D2, D3, D4, D6** **P1, P3** **O1, O3**
2. Further developing Climate-ADAPT as the 'first-stop shop' for adaptation information in Europe.	**2.1:** Establish an EU Observatory for climate change and health.	**D2, D3, D4, D6** **P1, P2** **O1, O2, O3**
3. Strengthening the evaluation, monitoring, reporting and implementation of adaptation strategies	*No mini-assessment*	**D4, D5** **P1, P2** **O1, O2, O3,**
4. Prioritising nature-based adaptation, including coastal protection and green and blue infrastructure.	**4.1**: Building inter alia on relevant provisions under the Convention on Biological Diversity (CBD) and on the new IUCN Global Standard for Nature-based Solutions*, promote the deployment of robust and effective nature-based solutions (NBS) for adaptation to climate change, notably by stepping up and scaling up their implementation and by further developing methods and tools to a) assess the vulnerability and expected resilience of planned NBS to projected climate change; b) determine their cost-efficiency and effectiveness with regards to their expected adaptation functions; c) quantify their wider economic, social	**D1, D4, D5** **P2, P3** **O2, O3**

[168] Actions and measures are directly linked to the specific objectives (O), and seek to address their associated problems (P) and problem drivers (D).

ACTION	MEASURE	LINKING TO*
	and environmental co-benefits.	
5. Stepping-up efforts to build resilience in cities and empower local action.	**5.4:** Launch a climate change adaptation Policy Support Facility / Technical Assistance project supporting local climate change adaptation action through the Covenant of Mayors.	**D2, D3, D5, D6 P1, P2, P3 O1, O2, O3**
	5.6: Support vulnerable groups and enterprises through education, social security policy and reskilling initiatives for green jobs and new business models, including through the European Skills Agenda and European Social Fund Plus (ESF+), with a particular focus on adaptation and resilience.	**D2, D3, D4 P2, P3 O2**
6. Further mainstreaming and integrating adaptation in EU legislation and instruments	*No mini-assessment*	**D3, D4, D5, D9 P1, P2, P4 O1, O2, O4**
7. Climate Proofing of Infrastructure and Disaster Risk Management	**7.2:** Climate proofing of guidelines and standards to ensure the adaptive capacity and climate resilience of new infrastructures in Europe and abroad.	**D4, D5, D7, D9 P2, P3, P4 O3**
8. Closing the Climate Protection gap - microeconomic aspects of adaptation to climate change.	**8.2:** Funding instruments: mainstreaming of resilience, adaptation and climate risk management concerns in the design of calls and of project selection criteria and the identification of "EU interest" resilience upgrades required for interconnected critical infrastructure.	**D2, D3, D6, D7 P1, P3, P4 O1, O3, O4**
	8.3: EU policy used to further influence private finance. Focus on the importance of adaptation ambition in the revision of the Non-Financial Reporting Directive and of prudential rules.	**D2, D3, D6 P2, P3 O3**

** Please refer to chapter 2 (drivers and problems) and chapter 4 (objectives)*

Option 2: Deepening of existing actions and addition of novel actions to Strategy

In addition to the measures listed in Option 1 (which are also included in option 2), Option 2 adds new actions to the Strategy, each of which includes a number of novel and innovative measures. The following Table 7 lists the measures for which more detailed mini-assessments to contribute to the IA have been carried out (see Annex 7 for these assessments). The full list of measures included in this option is presented in Annex 6.

This option is one of greater political ambition in EU adaptation policy, on par with international commitments. It expands into thematic areas of prime importance (e.g. ecosystems, innovation, freshwater) and broadens the approach to other national relevant processes (e.g. fiscal frameworks. See Box 2 below). By seeking to add greater policy coherence to the Union's actions on adaptation, including internationally, it sets itself apart from the baseline. Most importantly, it brings full thrust to the achievement of the international objective (O4).

Table 7: Novel actions and their connectivity to the Drivers (D), Problems (P) and Objectives (O)

NOVELTY ACTION	MEASURE	LINKING TO*
9. Supporting partner countries and regions in their efforts on climate change adaptation and disaster management	**9.1:** Support upgrade and implementation of Nationally Determined Contributions (NDCs) and NAPs by providing technical and financial assistance dedicated to: building capacity at national and sub-national level, developing adaptation plans in line with national priorities and vulnerabilities; supporting climate-proof structural governance reforms; implementing monitoring and evaluation schemes to assess progress towards climate change resilience; enhancing coherence with national and local disaster risk reduction strategies and environmental sustainability strategies; promoting nature-based solutions, especially in coastal areas.	**D4, D5, D8, D9 P1, P2, P3, P4 O1, O2, O3, O4**
	9.4: Work with leading institutions in Africa, the Caribbean, the Pacific and Asia sub-regions to promote and support climate change adaptation and disaster risk management approaches, and develop regional adaptation plans and action: Propose regional programmes in Africa (e.g. with AU or regional economic communities) to develop regional adaptation and DRR	**D2, D5, D9 P2, P4 O2, O4**

NOVELTY ACTION	MEASURE	LINKING TO*
	strategies.	
10. Scaling up international adaptation finance and disaster risk financing, unlocking innovative sources of finance, and mobilising private finance	**10.3:** Use the External Investment Plan and the European Fund for Sustainable Development to leverage private sector finance for climate change adaptation, in line with the EU Sustainable Finance Taxonomy, and promote the engagement of partner countries in the International Platform for Sustainable Finance.	**D4, D6, D7, D9** **P3, P4** **O3, O4**
	10.5: Enhance climate and sustainability proofing of all EU external investments, including grants, guarantees and blending instruments, by enhancing Environmental and Social Safeguards due diligence, monitoring and follow-up processes	**D6, D8, D9** **P2, P3, P4** **O2, O3**
11. Strengthening EU engagement globally and learning from adaptation frontrunners.	**11.4:** Strengthen the production and delivery of user-friendly and timely climate data and services), in particular through the promotion of space-based application, the use of Copernicus Climate Change Services and Emergency Management Services in partner countries.	**D2, D3, D8** **P3, P4** **O2, O4**
12. Adaptation Solutions / Horizon Europe Mission on adaptation to Climate Change, including Societal Transformation	**12.1:** Implement the Horizon Europe Mission on Adaptation to Climate Change, including Societal Transformation with the objectives of preparing Europe, Accelerating the transition, and building deep resilience.	**D2, D3, D5, D6** **P1, P2, P3** **O2, O3**
	12.2: Develop forestry agriculture and ecosystems decision support tools, including trees and crop suitability, weather and climate forecasts and disturbance risks	**D2, D3, D4** **P1, P2, P3** **O2, O3**
13. Closing the Climate Protection Gap - macroeconomic aspects of adaptation to climate change.	**13.1:** For public finance/macro financial stability risk: Introduce a stepwise approach whereby the Commission engages a discussion on national disaster risk management frameworks with finance ministers' fora, underpinned by best practices and evidence from EU Member States and EU level scenario analysis and stress testing. This would lay the ground for mainstreaming climate change in the national fiscal processes.	**D4, D6, D8** **P2, P3** **O2, O3**
14. Ensuring the availability of fresh water.	**14.1:** Use the Common Implementation Strategy of the Water Framework Directive to improve policy implementation for securing sustainable water use across sectors, through improvements to and intensification of among others: water resource allocation and management plans, water-permitting systems, cost recovery through water pricing incorporating externalities, or cost recovery rate calculations.	**D3, D4, D6, D7** **P1, P2, P3** **O2, O3**
	14.3: Promote Water Safety Plans under the Common Implementation Strategy to reduce exposure to contaminated or acutely polluted water due to climate impacts such as low flows, higher water temperature or flooding, and also to ensure availability of adequate quantities of tap water.	**D2, D3, D4** **P1, P3** **O3**

** Please refer to chapter 2 (drivers and problems) and chapter 4 (objectives)*

Box 8: Disaster Risk Management, financing strategies, and National Fiscal Frameworks

Disaster risk management (DRM) and fiscal and financial strategies are key settings for robust adaptation strategies. These frameworks provide citizens, businesses and policy-makers with an evaluation and oversight of risks, of the civil protection resources and fiscal and financial tools to address the human, material and economic consequences of disasters in the emergency, recovery and reconstruction phases.

A thorough understanding and assessment of natural and man-made disaster risks and the evaluation of the impacts if disasters occur is essential for building robust frameworks for disaster management and financing strategies. Citizens, local authorities and businesses may find this information useful for building in certain areas, subscribing to the right type of disaster insurance, setting business or to invest in projects that increase resilience to climate change, in particular to prevent and mitigate effects of climate driven disasters. Moreover, understanding the financial impacts of disasters by Finance Ministries is the basis for designing the fiscal and financial strategy.

The impacts of disasters can be addressed ex-ante through physical risk reduction measures where DRM plays a central role. Along climate-change resilience to disaster risks, financial resilience can be enhanced by endowing the national budgetary processes with necessary financing structures and risk transfer mechanisms to avert financial distress. This is all the more relevant as public authorities are responsible for the economic, financial and fiscal policymaking, planning of public investment and prioritising public expenditures and act as the provider of support and insurer of last resort in case of disaster.

An encompassing approach to understanding and dealing with disaster risks is based on several principles:

- Developing the national fiscal risk management framework to include disaster risks: building on quantitative disaster risk assessments to ensure rapid, timely and commensurate availability of funds in the emergency, recovery and reconstruction phases;
- Announcing ex-ante the rules regarding the post disaster financial compensation to ensure adherence to the solidarity arrangements and reducing moral hazard; this clarifies the allocation of disaster costs and promotes risk transfer instruments such as private insurance;
- Having in place governance rules for the monitoring and evaluation of the effectiveness of public funds disbursed in dealing with disasters and disaster risks: public investments in projects for risk reduction and adaptation, financial compensation and reconstruction of public assets and infrastructure, targeted financial compensation (unemployment, business continuity, etc.);
- Involvement of private and public actors in promoting financial resilience and offering financial instruments, a framework and risk sharing arrangements to deal with the financial consequences of disasters;
- Promoting the resilience of the financial (insurance) sector with respect to disaster risks through proper regulation and incentives, stress testing, etc.

Options discarded at an early stage

The increased urgency of climate action, and increased evidence of climate impacts, is reflected in the mandate of the new Commission. The need for and value of the EU Adaptation Strategy was confirmed in its 2018 evaluation. As there is no serious political consideration of not having an active policy on adaptation, a 'no EU Adaptation Strategy' option was not considered. Discontinuing the Adaptation Strategy would also be difficult from a legal perspective as international commitments, such as those in Paris Agreement and under the UNFCCC, require the EU to take various actions on adaptation to climate change.

Similarly, a standardised 'one-size-fits-all' type regulation, mandating Member States and other stakeholders to take specific actions (like strategic retreat from areas that are sure to be affected by sea-level rise, or stopping support for non-climate adapted crops, making climate insurance mandatory at EU-level etc.) was also not considered suitable for further assessment. As adaptation is an issue which is very specific to circumstances, spatial and temporal variables, it would be ill suited for top-down regulation to set more than a few overarching requirements. Trying to take a comprehensive top-down approach would likely be inefficient, costly and potentially lead to maladaptation. It would also raise questions relating to the subsidiarity and proportionality of EU action.

6. WHAT ARE THE IMPACTS OF THE POLICY OPTIONS?

This chapter presents the main impact assessment of the policy options. The impact indicators that are assessed were selected based on the impact screening presented in Annex 5. An aggregated impact assessment at the policy option level is carried out, based on the mini-assessments of the selection of measures presented in chapter 5. These mini-assessments are detailed in Annex 7 to this report. Key points from the assessments of these individual measures are highlighted in the text, but the options are evaluated as an aggregate of all of the mini-assessments and also relevant reflections on the potential impact of the full list of measures presented in Annex 6. The Options are all assessed for their impact compared to the Baseline option (see below), not their absolute impact. Option 2 also includes impacts assessed for Option 1, as it subsumes all Option 1 actions and measures.

Assessment is necessarily qualitative in many aspects

The intended impact pathways of the actions and measures in the Adaptation Strategy are typically quite long-term, indirect and acting in concert with other instruments, or in anticipation of action by others. This makes it difficult to attribute impacts to the policy Options. The distinction between direct and indirect impacts is made across the assessments and is important. Direct effects are expected to be applicable in the short term. Indirect impacts are typically relevant to measures that promote, support or enable action, and which therefore generally induce impacts on a slower timescale, and where the attribution of impacts to the Strategy is more difficult.

Furthermore, analytical tools and instruments in the context of climate change adaptation are not yet developed enough to provide good resources or methodologies for the assessment of the impact of adaptation measures[169]. There are particular deficiencies in the assessment of costs and effectiveness of measures, which make quantitative assessment very difficult. Further research is necessary to develop tools and approaches to improve the possibilities for modelling such impacts[170]. Therefore, out of necessity the approach and the consequent comparison in chapter 7, is qualitative and cannot offer a traditional cost-benefit perspective to the same depth possible for other programmes or policies.

The adoption or take-up of measures proposed under the different options of the Strategy is important to the assessment of impact. The Options include very few measures that are mandatory for the targeted groups. Therefore, assumptions of the voluntary take-up of the measures are important. In the mini-assessments in Annex 7 the assumptions of take-up used for the quantitative and qualitative assessments are detailed, these are based primarily on desk review, which used data on predecessor measures, or similar measures in other areas, to

[169] See Study on Adaptation Modelling, Forthcoming 2021
[170] Ibid

inform a judgement on potential take-up of a measure beyond the baseline. As the measures offer benefits to participants (e.g. training, support, data, information, funding) mostly with low reciprocal requirements then take-up is typically assumed to be reasonable. Nevertheless, this assumption on take-up can be regarded as one of the main uncertainties in the assessment, the reality could be higher or lower than assumed.

Temperature scenarios

The impact assessment applies a sensitivity analysis-type approach in an attempt to capture how different climate pathways might affect the expected impact of the Options in two temperature range scenarios for global climate change projections; in general, the relevance and impact of a measure increases as the temperature increases. Measures that have positive impacts even in the 'low' (i.e. Paris Agreement compatible) range of temperature scenarios (+1.5°C and +2°C) could be considered 'no-regret' measures, good to pursue in any case. Some measures may only become attractive in the high temperature scenario (+4.0°C). We return to this in sections 8 and 9.

Economic modelling

The impact assessment combines results from economic modelling of the impacts of the policy measures along with qualitative analysis based on desk review and stakeholder inputs. The economic modelling approach is further detailed in Annex 8 of this report, but in summary is based on macro-econometric modelling using the GINFORS model[171]. This models the economic feedbacks expected from selected measures for which mini-assessments were carried after making assumptions on how these measures will affect demand, supply and damages in the directly affected sectors. Nevertheless, this modelling is subject to a number of limitations[172], so results are accompanied by a qualitative indicator supporting the assessment.

Summary of impacts

The following table (4) provides an overview of the assessed impacts of the two policy options relative to the baseline (i.e. continuation of the 2013 Strategy). This is done across the most representative temperature scenarios used for sensitivity analysis (i.e. a Paris Agreement warming scenario of 2.0°C by 2100 and one of 4°C). Scenarios achieving 1.5°C and 2.0°C by 2100 are still similar in temperature impacts by 2050, with increasing divergence after 2050. Especially for impacts assessed qualitatively, it is not feasible to usefully differentiate these two scenarios, therefore only the 2.0°C is presented in the summary table[173]. Instead, impacts of no abatement are already more pronounced by 2050 in the scenario resulting in a 4°C temperature change by 2100.

For the macroeconomic and employment indicators, both quantitative and qualitative assessments are provided. The quantitative assessments are based on the economic modelling of the impact of the measures for which mini-assessments were carried out (see Annex 4 and Annex 7). For the quantitative indicators on economic welfare and employment, percentage point difference in annual GDP and employment values in 2050 relative to the baseline.

[171] https://www.gws-os.com/de/index.php/global-developments-and-resources/models/model-details/ginfors.html

[172] See EC DG CLIMA (2020) Study on Adaptation Modelling, Task 3 Recommended Approach to Analysis and Modelling for a more comprehensive detailing of the significant difficulties and limitations that remain for quantitative modelling of climate impacts and adaptation action.

[173] Later in this chapter, quantitative modelling results for the 1.5 degree scenario are presented for reference, as it was feasible to make this differentiation in the modelling. The modelling shows that the differences with the 2 degree scenario are relatively small, and smaller than the difference between the 2 and 4 degree scenario.

Comparison with the absolute numbers from the baseline is provided in the following sections, and addresses the point that although the options are better than the baseline, they still act only to reduce the scale of losses due to climate damages. Furthermore, given the limited extent to which the selection of the proposed measures were captured by the economic model used, it is very likely that these values (for the majority benefits) are lower bounds, under-representing the positive impacts of the strategy along these dimensions. This is a known problem in adaptation policy[174] i.e. that its benefits are undervalued by not integrating co-benefits the adaptation measures have, and by not accounting for the avoided damages of climate change. The qualitative indicators aim to address these limitations, to include a view on measures which were not modelled, and to bring in consideration of the broader issues related to economic welfare and employment, for example skills. It is also important to note that whilst the numbers for economic welfare may appear small at this aggregate EU level, they can represent much more significant sums for localities particularly affected by climate change, and which would also significantly benefit from the Options.

Table 9 uses a negative/positive scale from (---/--/-/0/+/++/+++). For all qualitative indicators, the baseline would be represented as a zero (i.e. the reference). This is not shown in the table, but the situation the baseline represents is described in the following sections, which provide the full assessment per impact indicator and option. The colour shading emphasises the assessed impacts: darker shading indicates greater impact, with red for negative and green for positive impacts. The scores are based on the detailed assessments in the following sections, which are built up from the mini-assessments provided in Annex 7 and high-level consideration of any significant additional impact of all measures under each Option, as listed in Annex 6.

Table 9: Summary of impact assessment relative to the baseline

Impact (by 2050)	Sub-indicator	Paris scenario (2.0°C by 2100[175])		High temperature scenario (+4.0°C by 2100[176])	
		Option 1	**Option 2**	**Option 1**	**Option 2**
Macroeconomic	Change in economic (welfare) (p.p. GDP/year)	**+0.22pp**	**+0.22pp**	**+0.47pp**	**+0.47pp**
	Qualitative (+/-)	+	+/++	+/++	++
Competitiveness trade and investment	Impact on competitiveness, trade and (climate resilient) investments (+/-)	+	+/++	++	++/+++
Regulatory burden on businesses	Regulatory burden (+/-)	**0/-**	**-**	**0/-**	**-**
Innovation and research	Impact on adaptation innovation (+/-)	+	+++	+	+++

[174] https://unfccc.int/resource/docs/publications/pub_nwp_costs_benefits_adaptation.pdf
[175] Quantitative modelling results are presented for 2050 for an approximate 2.0°C temperature increase (by 2100) scenario based on RCP 4.5; in the following sections, results are also presented for a 1.5°C temperature increase (by 2100) scenario based on RCP 2.
[176] Quantitative modelling results are presented for 2050 for an approximate 4.0°C temperature increase (by 2100) scenario based on RCP 8.5

Public authorities and budgets	Public spending on adaptation (+/-)	++	+++	++	+++
Employment	Change in employment by 2050 (p.p.)	**+0.37pp**	**+0.42pp**	**+0.79pp**	**+0.80pp**
	Qualitative analysis (+/-)	+	+/++	**0**	+/++
Income distribution, social protection and social inclusion (of particular groups) (+/-)		+	+	++	++
Public health & safety and health systems (+/-)		+	++	++	+++
Climate resilience (+/-)		++	+++	++	+++
Quality of natural resources/fighting pollution (water, soil, air etc.) (+/-)		**0**/+	+/++	+	++/+++
Biodiversity, including flora, fauna, ecosystems and the services they provide and landscapes (+/-)		**0**/+	+/++	**0**/+	++/+++
Impacts in 3rd countries and international relations(+/-)		**0**/+	++/+++	**0**	+++

Note: the table uses a scale from (---/--/-/0/+/++/+++). The scoring represents, compared to the baseline, --- large negative, -- medium negative, - small negative, 0 neutral, + small positive, ++ medium positive, +++ large positive. Scores can also fall between these categories and are assessed as e.g. 0/+ or ++/+++. Quantitative results available for only a selection of impacts, and the score and shade consider both quantitative and qualitative assessments.

Economic impacts

Option 0 (Baseline)

Macroeconomic environment [impact measured in economic (welfare) losses (€)].

The PESETA IV study estimated the economic losses from climate change in different climate scenarios, this found that in a +1.5°C scenario would lead to a €42 billion/year (0.33% of GDP) loss, a 2.0°C scenario a would lead to a €83 billion/year (0.65% of GDP) loss, and a +3.0°C scenario a would lead to at least a €175 billion/year (1.38% of GDP) loss. An estimate in the PESETA III study for a +4.0°C scenario suggested an economic welfare loss of 1.92% of GDP (approximately €245 billion/year using the PESETA IV values)[177].

The COACCH project has also used a large number of sectoral models and put these into a macroeconomic model to estimate the impacts of climate change in Europe at Member State and regional level (NUTS2). The modelling results find higher estimates than the PESETA study for the same levels of temperature change. In the majority of EU countries and regions, climate change losses are estimated at 1-2% of GDP by 2050. However, there are strong distributional patterns and countries and regions in Southern Europe experience much larger impacts. These impacts increase significantly under 3° and 4°C scenarios. As an example, the

[177] All values from the PESETA work are valued in 2015 euros and represent annual damages in the year 2100. The PESETA scenarios are based on climate models that estimate the impacts of different temperature features. They provide an analysis of adaptation policies in river and coastal floods that would be in place to limit the damages. PESETA uses historical baselines for damages and impacts up to 2010, and therefore does not include any impact the 2013 Adaptation Strategy has already had (and its continuation would have) on reducing the identified damages.

COACCH study estimates that coastal flood damages in Europe could reach more than €500 billion/year by the 2080s under the RCP4.5 scenario and could exceed €1 trillion for higher warming scenarios (RCP8.5)[178]. These studies illustrate the scale of potential economic damages from climate change, growing with the temperature scenarios and over time.

Both PESETA IV report and the COACCH project point out that there is a clear north-south divide in the regional distribution of welfare losses. According to PESETA the sum of impacts in northern regions are relatively small or even positive for some scenarios (e.g. northern Europe with 1.5°C and 2°C) as these regions experience gains from climate change for some of the sectors considered (e.g. agriculture, energy supply). In southern EU regions, the impacts are mostly negative. As a result, aggregated welfare losses in southern regions are several times larger compared to those in the north of Europe. The new COACCH numbers for costs are much higher[179], especially for the second half of the century, and for high temperature scenarios. This takes into account increasing sea-level rise, and socio-economic drivers.

The modelling in this work is based on the PESETA IV climate damage results, the baseline outputs are presented below and show losses increasing over time and with temperature scenario to around 1.1% of GDP losses annually by 2050 in a 4°C scenario; this is consistent with the annual economic welfare losses of 1.92% of GDP by 2100 described above. For context, 1.1% of EU GDP corresponds to around €200 billion in current values. The losses primarily stem from health losses, followed by losses from floods and droughts, depending on the region. Losses vary by region, and are estimated to be highest in central southern Europe[180] (up to -1.55% [2050/4°C]), and lowest in northern Europe[181] (up to -0.80% [2050/4°C])[182]. As noted above, in comparison to COACCH, the numbers are a robust lower bound for losses.

Table 10 Annual welfare loss

Indicator	1.5°C		2°C		4°C	
	2030	2050	2030	2050	2030	2050
Annual welfare loss [% GDP]	-0.12%	-0.52%	-0.20%	-0.67%	-0.30%	-1.10%

Source: GWS modelling results

Competitiveness, trade and investment, measured by an indicator on the impact on competitiveness, trade and (climate resilient) investments (see Annex 5): In terms of competitiveness under climate change, climate disruptions can have important impacts, although the relative exposure of the EU compared to other competitor regions is not well understood. It is possible to offer insight in some sectors, for example a significant shift in the agricultural sector is expected, particularly a shift in agricultural production and yields between European countries. Changes in relative yields and productivity would result in agricultural losses in Southern and Eastern Europe, but are expected to create gains in Northern, Western, and Central Europe. On a global scale, the EU has a comparative advantage in terms of climate change impacts on agricultural production, which may positively affect its competitiveness. The Actions in the 2013 Strategy do not significantly

[178] COACCH (2019). The Economic Cost of Climate Change in Europe: Synthesis Report on Interim Results. Policy brief by the COACCH project. Editors: Paul Watkiss, Jenny Troeltzsch, Katriona McGlade, Michelle Watkiss.
[179] COACCH (2020 forthcoming)
[180] France, Slovenia, Slovakia, Czechia, Romania
[181] Estonia, Finland, Latvia, Lithuania, Denmark, Sweden
[182] A full summary of the modelling results is presented in an Annex.

address competitiveness concerns, aside from general pushes on knowledge gaps and climate resilience, therefore competitiveness risks exist in the baseline scenario.

In terms of trade, it was identified in chapter 2 that the 2013 Strategy does not consider climate impacts outside the EU, which are a particular risk for trade and supply chains of various industries. The lack of actions or measures in this area in the 2013 Strategy means that the baseline scenario is that these risks would be expected to be only addressed piecemeal by the most active firms and Member States. This poses a significant risk to firms that import from outside the EU, particularly SMEs, as they rarely have resources to plan and react to risks[183].

Actions 6, 7 and 8 of the 2013 Strategy addressed climate resilient investments from different angles and would continue to have an impact. The coming years would see the standardisation efforts of Action 7 start to bear fruit as standards are scheduled to be agreed in the coming years, this will provide an impetus towards climate resilient investments in the base case. This is increasingly needed in order to take into account, for example, the acceleration of the corrosion process in buildings induced by climate change and provide for measures to limit it. Action 8 would be supported by other recent policy developments, such as the 2018 Action Plan on financing sustainable growth, and the Taxonomy Regulation for climate change mitigation and adaptation. Combined these actions are intended to accelerate climate resilient investments significantly and Action 8 would be a (likely minor) complement to the work of these instruments'. Overall, the most effective of the existing actions would be on standards, with this having some impact on boosting investments through shifting industry standards.

Regulatory burden on businesses: The 2018 evaluation examined the costs and burdens on private and public stakeholders and found that these were very low overall, almost non-existent for the private sector, and very small for Member States as the 2013 Strategy has very few mandatory measures. In the baseline scenario, this would not be expected to change.

Innovation and research, measured by an indicator on the impact on adaptation innovation and innovation adoption: To date, Action 4 of the 2013 Strategy has addressed knowledge, adaptation modelling and region-specific intelligence, which has been generated by the EU's Horizon 2020 research programme and projects, and by the EC Joint Research Centre. The dissemination of adaptation innovations into the market is also accelerated by, for example, the Climate-KIC[184], which stimulates innovation in the European market. Looking forward, it would be expected that in a baseline scenario Action 4 would continue to guide research beneficial to adaptation through these policy instruments. Yet the persistence of knowledge gaps as highlighted in the 2018 evaluation and in this work, strongly suggests that knowledge and innovation deficiencies will remain, for example in relation to nature-based solutions. The impact of the 2013 Strategy on innovation would not be expected to vary with temperature scenarios, although the need for innovation would increase.

Public authorities and budgets, measured by an indicator on public spending on adaptation: At the moment, adaptation expenditures in public budgets are not transparently identified, and are therefore difficult to assess. Actions 1 and 3 of the 2013 Strategy promote the monitoring of adaptation expenditure at national and city level. Whilst some large cities, like Paris, have established a comprehensive monitoring system within which different adaptation

[183] COACCH (2019). The Economic Cost of Climate Change in Europe: Synthesis Report on Interim Results. Policy brief by the COACCH project. Editors: Paul Watkiss, Jenny Troeltzsch, Katriona McGlade, Michelle Watkiss.
[184] The Climate-KIC (Knowledge and Innovation Community) is supported by the EC European Institute of Innovation and Technology (EIT).

financing actions are labelled and tracked, this is quite rare and the existing Strategy has found little traction. Weaknesses in EU level monitoring and reporting, and a lack of commitment in Member States, were highlighted earlier in chapter 2. These each point to significant deficiencies in the 2013 Strategy in promoting public spending on climate resilience. In the baseline scenario it is expected that Action 1 and 3 would continue to only have limited success in highlighting the need for and enabling greater public spending on climate resilience. With no new measures to encourage and support public spending or action, it can be expected that in the baseline growth in spending will be slow and highly unlikely to match the scale and urgency of the adaptation need, particularly in high temperature scenarios.

Option 1

Macroeconomic environment: The actions and measures as part of this option attempt to directly or, most often, indirectly, reduce the economic welfare losses by increasing climate resilience in the EU by increasing the quality and reach of data, improving planning and risk management and by encouraging greater adaptation action and spending. Generally, the evidence is quite clear that EU sector adaptation has a positive cost-benefit ratio.

A qualitative assessment of the option would be likely to award a (+) impact on economic welfare, at least in the short term, but increasing over time, and also with increasing severities of temperature scenarios, as the effects of the measures fully manifest themselves in implementation, and the scale of losses avoided increases with the temperature and climate impacts. Particular highlights for impact potential are found in the measures to close the climate disaster loss and risk data gap (1.5) and closing the climate protection gap (8.2 & 8.3). The former measure would be expected to allow for better-informed decision making by public and private actors, which ensures better risk mitigation strategies and insurance coverage. The latter measures would particularly ensure damages for EU funded projects are reduced, and through greater transparency, private losses are similarly avoided.

The modelling results for Option 1 are presented below; they show losses increasing over time and with temperature scenario. The more ambitious actions under the Strategy are modelled to reduce the economic losses from climate impacts in each scenario. The improvements are driven by reductions in damages and increased spending in sectors such as construction and health. The results vary by region, such that in a 1.5°C scenario the central northern Europe region experiences almost zero losses. By 2030 in a 4°C scenario, the avoided damages compared to the baseline equate to some €20 billion/year. The differences in regional damages across the temperature scenarios, relative to the costs of implementing the modelled measures, mean that in percentage point terms the annual welfare loss gain compared to the baseline, whilst still positive, is smaller in percentage point terms in the 2°C than 1.5°C scenario.

Table 11: Annual welfare loss – change in option 1 compared to baseline

Indicator	1.5°C		2°C		4°C	
	2030	2050	2030	2050	2030	2050
Annual welfare loss [% GDP]	-0.08%	-0.23%	-0.12%	-0.45%	-0.18%	-0.63%
Change compared to baseline [GDP p.p.]	+0.04	+0.29	+0.08	+0.22	+0.12	+0.47

Source: GWS modelling results

Competitiveness, trade and investment: the actions and measures under this option aim to increase investments in climate resilience, primarily indirectly. The improved data,

mainstreaming of climate resilience and other measures, are expected to encourage and enable decision makers towards more resilient investment decisions. The benefit of this would increase in higher temperature scenarios, as supply chain resilience would increase in importance. As with the indicator for economic losses, particular highlights for impact potential are found in the measures to close the climate disaster loss and risk data gap (1.5) and close the climate protection gap (8.2 & 8.3). The former measure would allow investments to better avoid or mitigate climate risks, and the latter measures would ensure that EU investments take climate resilience more effectively into account and that private investments are more transparent on their exposure to climate risks, encouraging more resilient investment choices. *Overall assessment of Option 1 impact: + (low temp. scenarios) ++ (high temp. scenarios)*

Regulatory burden on businesses: The additional burdens and costs to private stakeholders are estimated very low, as few of the actions and measures are mandatory. Requirements for open data, improved access and greater transparency in reporting can impose additional costs for (mostly) financial sector stakeholders compared to the baseline. These would be expected to be more than offset by the benefits of improved data sharing and access, and also the co-benefits of a number of other measures under Option 1, such as those with a focus on improving workforce skills and developing sector specific knowledge; in addition, the overall reduction in economic losses at the macroeconomic level could be expected to bolster competitiveness of private stakeholders. The impact on non-financial SMEs is expected to be a minor positive impact compared to baseline, as the resilience of the overall operating environment increases. The cost impact would not change across temperature scenarios, although the co-benefits to businesses of the measures would increase. *Overall assessment of Option 1 impact: -/0*

Innovation and research: this option includes two actions (1 & 2) which directly address the objective of improving knowledge of climate impacts and solutions, whilst a number of the other actions also indirectly address knowledge, innovation and innovation adoption. Specifically under action 1 the development of a Research, Development and Innovation (RDI) roadmap and supporting models and tools will organise efforts towards specific knowledge gaps. Furthermore, a variety of measures are designed to provide better, more granular data, addressing the local level, and accessible to a broader audience, which will fill gaps, spur further research and boost adaptation efforts and the adoption of measures. Efforts under action 2 to improve the use of expert networks and provide exchange platforms would be expected to increase the dissemination of relevant knowledge of climate risks and solutions. In addition, measures under action 4 encourage further knowledge development, and the piloting and adoption of adaptation measures, particularly nature-based solutions, which can provide an important boost to innovation more broadly. No significant variation in impact is expected in different temperature scenarios. The implementation of actions in agriculture is stimulated by the EIP Agri[185] operation groups and thematic focus groups in the context of the Common Agricultural policy. *Overall assessment of Option 1 impact: +*

Public authorities and budgets: this option includes various actions with a strong focus on public authorities, including under action 3 which focuses on strengthening their planning and strategies, whilst bolstering and harmonising monitoring and reporting. Moreover, and under action 5, this includes further technical support to local authorities and strengthening the Covenant of Mayors, and other actions on mainstreaming that can bolster local action.

[185] https://ec.europa.eu/eip/agriculture/en

The linking of EU funding to participation in the Covenant of Mayors and the consequent encouragement of climate planning and action, would be expected to have an important influence on public spending on climate resilience. In addition, the measures that provide technical support, local data and mainstreaming of adaptation in other policies, mean that the expertise, tools, data and resources available to public authorities will be improved. Specifically, the sharing of higher quality disaster loss data will allow public authorities to better target, plan and prepare their responses to climate disasters (see measure 1.5). Overall, it can be expected that as a result climate resilience will be more readily taken into account by public authorities and public spending which could be considered, as climate resilience spending is likely to increase as a proportion of existing spending. The Option may also result in greater public spending on resilience, as once plans are in place and reporting frameworks established could incentivise their implementation. The Option does include measures that will increase the **costs incurred by public authorities**, in terms of both increased reporting requirements, or of additional resources needed to improve climate-related losses data collection. The alignment and harmonisation of reporting, and further guidance and technical support, will offset at least part of any additional costs. No significant variation in impact is expected in different temperature scenarios. *Overall assessment of Option 1 impact: ++*

Option 2

Macroeconomic environment: The actions and measures as part of this option attempt to directly or indirectly reduce the economic welfare losses by increasing climate resilience in various ways. For reference, The EU's green economy (i.e. environmental goods and services for environmental protection and resource management is a small but growing segment of the economy, providing ~ EUR 300 billion GVA per year (~ 2% of EU GDP) and 4.5 million green jobs (ESTAT 2016 figures).

The macroeconomic impacts for the EU are not that strong for actions 9, 10 and 11, which have a specific international focus. Whilst there are indirect benefits of reduced economic losses in partner countries, these are addressed in the following indicator on competitiveness, trade and investments. The main economic welfare benefits assessed derive indirectly from action 12 which can bring gains and/or reduced losses for the forestry sector; from action 13 to close the climate protection gap, which will reduce overall macroeconomic exposure to climate damages; and through action 14 which focuses on resilience in the water sector and will serve to protect the sector itself and the multiple other sectors that are affected by it, particularly agriculture, food and drink, services and manufacturing. These will each have small positive macroeconomic effects. Overall the impact of Option 2 could be ranked as (0/+), which when added to the (+) estimated for option 1, would result in a qualitative assessment of a *(+/++)* impact on economic welfare. The impact of the option may increase with higher temperature scenarios, as the scale of losses avoided increases with the temperature and climate impacts.

Modelling of the impact of the option focuses on the potential changes in productivity and damage avoidance to the land-based sectors (forestry, agriculture) as part of Action 12, the other actions were not suitable for modelling. The quantitative results of the modelling show the following impacts.

The modelling results for Option 2 are presented below; these are the same as for Option 1 as the modelled measure for Option 2 does not have a significantly different impact at this level of granularity. A small difference is observed for the connected employment impact.

Table 12: Annual welfare loss – change in option 2 compared to baseline

Indicator	1.5°C	2°C	4°C

	2030	2050	2030	2050	2030	2050
Annual welfare loss [% GDP]	-0.08%	-0.23%	-0.12%	-0.45%	-0.18%	-0.63%
Change compared to baseline [GDP p.p.]	+0.04	+0.29	+0.08	+0.22	+0.12	+0.47

Source: GWS modelling results.

Competitiveness, trade and investment: this Option addresses the competitiveness, trade and investment impact in two main ways. Firstly, the international actions (9, 10 and 11) each provide measures that seek to strengthen climate resilience in partner countries by providing technical and financial assistance, knowledge sharing and partnerships. The potential impact of these measures on resilience is unclear, and the trade and investment benefits, whilst likely to be positive, are likely to be small. On competitiveness, the proposed partnership and alliance approaches, especially in selected regions in Africa, the Balkans and elsewhere, may provide benefits for EU firms through reduced disruptions to global supply chains (for reference, the size of such impacts has been estimated at greater than zero but less than 0.5% of GDP in the case of Germany).

Other potential benefits may arise from the direct investments made through EU external funding, and through the goodwill in cooperative approaches. Taken together, all of these benefits are likely to equate to only a small (e.g. 0/+) positive. Secondly, the other actions address the climate protection gap and specific sectors such as water and forestry, each of which can affect climate resilience, primarily indirectly. Action 12 is particularly relevant for agriculture and forestry and would build upon the measures under Action 1 from Option 1, and would provide knowledge to support more climate resilient investments in these sectors, bolstering their productivity and competitiveness. Action 13 to close the climate protection gap could be expected to strengthen and complement Action 8 in option 1, and to further encourage decision makers, particularly finance ministries at national level and the financial sector, to ensure that their investments better avoid or mitigate climate risks. Action 14 would bolster investments in the water sector. Overall, we would see a small positive benefit of the Option (0/+). The impact on SMEs would not be expected to vary significantly from this overall assessment. The benefit of the Option would be expected to increase in higher temperature scenarios, as the greater international resilience would become more important to EU competitiveness, trade and investment. Building upon the + (low temperature) / ++ (high temperature) assessment for option 1, our O*verall assessment of Option 2 impact: +/++ (low temp. scenarios) ++/+++ (high temp. scenarios)*

Regulatory burden on businesses: The additional burdens and costs to private stakeholders in the EU are estimated very low, as few of the actions and measures impose mandatory measures. The international actions (9, 10 and 11) provide no new requirements for EU firms; indeed, they are more likely to improve access to new opportunities and markets than to impose additional costs, for example providing new international users for services such as Copernicus (9.6) or customers for insurance products (10.2). Action 12 only provides support and therefore no additional costs. Action 14 may indirectly have a broader cost impact on firms as it targets improved policies and their implementation, the main costs would be attributed to the other policies, i.e. Eco-design if additional water efficiency requirements for appliances were introduced, although a contributory role of the Strategy would be noted. Policy reforms for the water sector on pricing, permitting and cost recovery would impact upon firms, probably to the benefit of firms in the water sector but by increasing costs for water users. The macroeconomic impact of this was modelled, and was marginal, although there may be distributional impacts for firms, for example, major water users in industry and agriculture could see cost increases. Overall, weighing the benefits and costs to firms we

would see a potentially small negative impact of the Option (-/0). The impact on SMEs would not be expected to vary significantly from this overall assessment. The cost impact would not change across temperature scenarios, although the co-benefits to businesses of the measures would increase. *Overall assessment of Option 2 impact: -*

Innovation and research: this option includes one action (12) which directly addresses the objective of improving knowledge of climate impacts and solutions, whilst a number of the other actions also indirectly look to develop and apply new knowledge, e.g. Action 13 climate stress tests, Action 14 water policy measures. Specifically under action 12, the Horizon Europe Mission on Adaptation is expected to have an important influence on accelerating adaptation innovation through establishing 100 deep demonstrations of climate resilience across Europe. Action 1 of Option 1 will identify measures for the land use, agriculture and forestry sector, and measures under Action 12 in disseminating and implementing these solutions can have an important beneficial impact in these sectors. A toolbox for faster decision making by policymakers and practitioners may also prove useful, although further clarity would be needed. The international actions may also support innovation by providing for exchange and cooperation mechanisms to bring international innovations from partner countries to the EU, where stakeholders anticipate partner countries already exposed to major climate risks will have developed practical solutions from which the EU can learn. Overall, we expect to see a positive impact (+) on innovation and research resulting from Option 2, but no significant variation in impact across temperature scenarios. Building on the + assessment for option 1, our O*verall assessment of Option 2 impact: ++*

Public authorities (and budgets): the internationally oriented actions under this option have important implications for public authorities. Within the EU, the main implications are for the EU External Action and Development activities, which will find a much-increased focus and need for spending on climate resilience. This can significantly increase the EU climate resilient spending internationally. This would be achieved by measures under Action 9 and 10 ensuring the alignment of spending with disaster risk reduction and national adaptation plans in the partner countries, and by moving towards a balance between climate change mitigation and adaptation in EU spending.

Member State public authorities are not strongly impacted by the internationally oriented actions, nor by Action 12, but Actions 13 and 14 can have an impact on public authorities. Action 13 on the climate protection gap includes engaging with EU Member States (Finance Ministries fora) on disaster risk management and disaster risk financing strategies and exploring options to better reflect climate change risk in fiscal policy and EU-level fiscal sustainability assessments (improve estimates and reporting of fiscal impact of disasters as well as of fiscal costs of adaptation and mitigation measures promote risk transfer instruments). These measures are expected to contribute to closing of the climate protection gap as Member States better identify and address gaps in climate disaster risk management, and better assess related fiscal sustainability risks. Action 14 encourages policy action in the water sector, which can lead to action within the Member States in piloting new policy measures, which given that public ownership is still common can have an impact on public spending. The overall thrust of the policies is towards increasing investment and cost recovery, therefore the impact in the sector is expected to see users pay more, with water firms, including those in public ownership, able to invest more, or require less public support.

The Option does include measures that will increase the **costs incurred by public authorities**[186], for the EU greater consideration of climate resilience in external finance will require greater efforts and amendments to existing processes. The international cooperation mechanisms, and creation of modelling tools, guidance, and monitoring and reporting mechanisms for natural disaster insurance, will each require resources to establish and implement. Costs to Member States are expected to be low and consist primarily in the time and resources necessary to engage with the monitoring and reporting of natural disaster insurance penetration, although it is noted that one of the measures (13.4) intends to streamline these aspects. Other engagement will take place through existing fora.

No significant variation in impact is expected in different temperature scenarios. Overall, we expect to see a positive impact (+) on innovation and research resulting from Option 2, but no significant variation in impact across temperature scenarios. Building on the ++ assessment for option 1, the O*verall assessment of Option 2 impact is: +++*

Social impacts

Option 0 (Baseline)

Employment: it has been estimated that up to 500,000 jobs could be created and a further 136,000 saved across the EU by 2050 in a reference scenario of some adaptation action (which assumed, differently to this study, 0.5% of GDP spent on adaptation)[187], compared to what would be expected in the absence of adaptation action. In an ambitious scenario, (assuming 1% of GDP spent on adaptation) these impacts would increase further. The impacts are net of the results from climate damages (and in some regions/cases benefits), changes to labour productivity and investment in adaptation activities. However, the development and take up of green jobs is heterogeneous across Members States, and they experienced different patterns in the promotion of green skills and jobs[188].

The largest impacts are estimated in the sectors in which investment will be made (construction) and those in which damages would be severe without action and which therefore benefit most from greater resilience (manufacturing, public utilities, retail and tourism). A few sectors in particular are likely to see the biggest investments and therefore the largest net employment gains due to investment in climate change adaptation: water management, construction, energy supply, and transport infrastructure. Analysis also suggests that proportionally the largest employment gains will be in Central and Eastern Europe[189].

The modelling employed in this work includes an assumed effect of the 2013 Strategy and make estimates of the baseline employment impact for 2030 and 2050. The modelled baseline outputs for employment are presented below and show reductions in employment, with the size of employment decline increasing over time and with temperature scenario to around 1.9% by 2050 in a 4°C scenario. Based on 2019 employment of 191 million people in the EU, 1.9% represents around 3.6 million job losses. The percentage value demonstrates a

[186] Assessment focused on the impact for the EU public authorities but note that the target of many of the actions of Option 2 is to strengthen and support public authorities in partner countries and that significant support, finance and expertise will be provided to this end. This is likely to have important beneficial impacts on climate resilience in partner countries and to encourage some matching increases in public spending on climate resilience in these countries. Part of the impact of this for the EU is seen above in the competitiveness, trade and investment impact indicator.

[187] Trinomics, TNO and Ricardo, for DG CLIMA (2014) Assessing the Implications of Climate Change Adaptation on Employment in the EU. Note: this study also models a baseline scenario of no adaptation action in which 410,000 jobs could be lost across the EU by 2050.

[188] Cedefop (2019). Skills for green jobs: 2018 update. European synthesis report. Luxembourg: Publications Office. Cedefop reference series; No 109. http://data.europa.eu/doi/10.2801/750438

[189] Trinomics, TNO and Ricardo, for DG CLIMA (2014) Assessing the Implications of Climate Change Adaptation on Employment in the EU

higher magnitude of impact than for the economic losses as relatively labour-intensive sectors are most effected. Again, losses vary by region, and compared to the distribution of the economic impacts. These are estimated to be highest in southern Europe[190] (up to -3.3% [2050/4°C]), and lowest in central northern Europe[191] (up to -0.25% [2050/4°C]). As noted previously, these numbers are likely to represent an underestimate of the losses.

Table 13: change in Employment

Indicator	1.5°C		2°C		4°C	
	2030	2050	2030	2050	2030	2050
Change in Employment [%]	-0.25%	-0.92%	-0.40%	-1.27%	-0.60%	-1.94%

Source: GWS modelling results

Income distribution, social protection and social inclusion (of particular groups): the impacts of climate change will be experienced unevenly across Europe, with some groups and places being particularly vulnerable and severely impacted, and some existing social problems being exacerbated by climate change. The impact on income distribution and the socio-economic inequalities (poverty, deprivation) that stem from this will be highly linked to the economic impacts, with particularly vulnerable regions in southern Europe, Alpine regions that rely on tourism and coastal regions threatened by sea level rise. Age-linked vulnerabilities and inequalities can also be exacerbated by climate change with elderly groups often less able to adapt, but more vulnerable to stress and damages from the climate impacts. Increased climate resilience can also go hand-in-hand with improved social conditions, as social co-benefits from investments in climate resilience can be achieved. The 2013 Adaptation Strategy does not provide for a significant specific focus on social inequalities, but could address these by supporting Member States to identify and take action on these vulnerabilities in their own Strategy development (action 1). As a result, whilst the 2013 Strategy Baseline option would have some benefit, it would not provide significant improvements on social issues.

Public health & safety and health systems: public health and civil emergency systems will come under significantly increasing pressure due to climate change, with the intensity of the pressure increasing with the temperature scenarios. Impact studies have estimated the increased morbidity and mortality expected due to climate change which are include both increases from heatwaves and decreases from reductions in extreme cold, the former being by far the larger of the two effects, as illustrated in the table 9 below. This illustrates some of the increasing pressure that will be placed on health systems as the temperature increases, but other impacts such as the impacts of extreme temperature on ambient air quality, ozone pollution during heatwaves, and particulate matter pollution from wildfires (one of the most dangerous air pollutants to human health), are also relevant.

Table 14: Summary of impact of heat and cold wave impacts

Impact	1.5°C	2°C	3°C
People annually exposed to a 50-year heatwave [million]	103	168	288
Annual fatalities from heatwaves [‘000s]	28.8	49.4	89.0
People annually exposed to a 50-year coldwave [million]	4.9	2.7	1.2

[190] Cyprus, Malta, Austria, Bulgaria, Greece, Italy, Spain, Portugal, Croatia
[191] Poland, Netherlands, Luxembourg, Germany, Belgium, Ireland

Annual fatalities from coldwaves ['000s]	0.03	0.02	0.01

Source: adapted from PESETA IV – NB: different temperature scenario used for high-end warming

Action 2 of the 2013 Strategy would continue to promote and pilot nature-based solutions, whose aims can include minimising the urban heat island effect, as well as have a positive impact on air quality, both of which can reduce pressure on public health systems. Yet, as noted in the 2018 Evaluation, the 2013 Strategy has not been particularly successful in promoting the adoption of nature-based solutions and without further action, this is not expected to change.

Option 1

Employment: the impact of the Option on employment is tied closely to the economic impacts on the macroeconomic environment and competitiveness. The earlier assessment showed that the impact of Option 1 on these parameters is expected to be positive, equivalent to a (+) on a qualitative scale as the actions stimulate climate resilience and reduce losses to welfare.

The impact on employment includes qualitative impacts on skills and other employment-related aspects. These are not a major focus of the Option or Strategy but this Option includes one measure (5.6) which aims to use the ESF+ and European Skills Agenda to support vulnerable groups with education and skills training for green jobs and with a focus on climate change adaptation and resilience. This measure will provide some (likely small given potential scale) benefit to skills and employment.

The modelled outputs for Option 1 for employment are presented below and show reductions in employment losses compared to the baseline. The more ambitious actions under the Strategy are modelled to reduce employment losses from climate impacts. The improvements driven by reductions in damages and increased spending in sectors such as construction and health. For context, each 0.1% change in employment represents approximately 200 000 jobs, therefore this option could save around 800 000 jobs/year by 2050 in a 2°C scenario.

Table 15: Change in Employment in option 1 compared to baseline

Indicator	1.5°C		2°C		4°C	
	2030	**2050**	**2030**	**2050**	**2030**	**2050**
Change in Employment [%]	-0.20%	-0.67%	-0.25%	-0.90%	-0.35%	-1.15%
Change compared to baseline [p.p.]	+0.05	+0.25	+0.15	+0.37	+0.25	+0.79

Source: GWS modelling results

Income distribution, social protection and social inclusion (of particular groups): this Option addresses climate vulnerabilities in multiple ways, and therefore social vulnerabilities. Specifically, Action 5 through the proposed Policy Support Facility could target assistance towards smaller cities and local authorities that are more vulnerable to climate impacts. Increased granularity of and access to data on damage and risk (Action 1), and the climate and health observatory (Action 2), will each identify specific social vulnerabilities due to climate change, enabling public authorities in the Member States to provide further support, and citizens and advocacy groups to more easily identify their risks and needs. Better dissemination of knowledge and data at geographically targeted and sector level will help sectors to adjust, reducing the geographical distributional impacts. Action 4, promoting nature-based solutions, aims to improve the quantification of social co-benefits of measures and contribute to their greater adoption; this better quantification of social impacts would

itself help to adjust spending and thereby address distributional effects. The option does not include further measures specifically addressing other social inclusion or protection issues. As damages increase with temperature scenarios, so does the mitigating effect of the proposed actions. *Overall assessment of Option 1: + (low temp. scenarios) ++ (high temp. scenarios)*

Public health & safety and health systems: this option includes a variety of measures that address public authorities and how they can ensure that civil emergency and health systems can respond to climate change impacts. Among the leading measures are those under Action 5 which encourage participation in the Covenant of Mayors and which therefore require local authorities to consider these systems and their climate resilience. Action 2 with the planned observatory on health and climate change addresses an important aspect of health system resilience, although primarily as an information tool to highlight vulnerabilities and enable comparisons, with the expectation that this helps public authorities to address potential deficiencies and risks in their health system, strengthening these systems compared to the baseline. Additionally, other measures to support greater data sharing and sectoral risk assessment (Action 1), and the use of climate-resilience guidance (Action 7) are intended to enable businesses and citizens to make better-informed choices and to reduce the overall burden upon civil emergency systems when climate disasters occur. The benefit of these measures will scale with the temperature scenarios, as greater resilience of civil emergency and health systems will be required in the event of higher temperatures and more extreme weather events. *Overall assessment of Option 1: + (low temp. scenarios) ++ (high temp. scenarios)*

Option 2

Employment: the impact of the Option on employment is tied closely to the economic impacts on the macroeconomic environment and competitiveness. The earlier assessment showed that the impact of Option 2 on these parameters is expected to be a small positive, equivalent to a (0/+) on a qualitative scale as the actions stimulate climate resilience and reduce losses to economic welfare. A similar qualitative impact of a small positive (0/+) can be expected for employment. The impact on employment will be driven primarily by the actions that bolster the land-based sectors (forestry, agriculture) and the water sector and its dependent sectors. The focus on the land-based sectors is important for more labour-intensive economies in the south, centre and east of the EU where these sectors typically represent a relatively larger share of the economy and employment.

The modelled outputs for Option 2 for employment are presented below and show reductions in employment losses compared to the baseline; these are quite comparable to, but a little higher than, those presented for Option 1, due to the positive impact of measures in the water sector. In the 4°C scenario, the 0.8% change is the equivalent of around 1.6 million jobs/year.

Table 16: Change in Employment in option 2 compared to baseline

Indicator	1.5°C (RCP2.6)		2°C (RCP4.5)		4°C (RCP8.5)	
	2030	**2050**	**2030**	**2050**	**2030**	**2050**
Change in Employment [%]	-0.20%	-0.67%	-0.25%	-0.85%	-0.35%	-1.14%
Change compared to baseline [p.p.]	+0.05	+0.25	+0.15	+0.42	+0.25	+0.80

Income distribution, social protection and social inclusion (of particular groups): this Option mostly has a focus on climate and social vulnerability outside of the EU, the

international benefits of which are addressed in section 6.5. Through action 14 for the water sectors, and to a lesser extent action 12 for the land-based sectors, the option can address climate vulnerabilities in the EU linked to these issues. This can provide socio-economic benefits to groups particularly vulnerable to damages from these sectors. However, the measures in the water sector, if successful in encouraging better water pricing would add costs to most households across the EU with negative impacts on low-income social groups. It is unclear if compensating measures to address water saving would offset these additional costs, but on balance it is likely Action 14 would have a small negative impact across the EU. Nevertheless, the Horizon Europe Mission on Adaptation has a strong focus on issues of equality and social justice, and as a result, the innovations, knowledge and pilots developed under this initiative are likely to provide significant social impact. In addition, Action 13 aims to address geographic inequalities by improving coverage for climate damages. Overall a broad balance between the negative impact on water and the positive impact of the other measures is assessed, so that the impact of Option 2 is scored as (0), which when added to the (+) estimated for option 1 in low temperature scenarios and the ++ in high temperature scenarios, would result in: *Overall assessment of Option 2: + (low temp. scenarios) ++ (high temp. scenarios)*

Public health & safety and health systems: Actions 12, 13 and 14 each have measures that indirectly address public health and safety systems, with a focus on the civil emergency more than public health aspect. Action 12, through the Mission on Adaptation, aims to assess the climate resilience of goals proposed under the Union Civil Protection Mechanism (UCPM) and through the EU4Health programme contribute to the understanding of societal climate-linked public health risks. Action 13 by engaging with finance ministries on climate resilience is expected to result in Member States and then in-turn regional and local authorities, to assess their climate vulnerabilities, and thereby to lead to greater protection against financial impacts of climate damages. Action 14 on freshwater would both improve the overall resilience of water companies and the water system, but would also ensure that climate impacts are integrated into Water Safety Plans across the EU, which would improve the preparedness of civil emergency services for water-related climate impacts. The benefit of these measures will scale with the temperature scenarios, as greater resilience of civil emergency and health systems will be required in the event of higher temperatures and more extreme weather events. Overall, Option 2 is assessed as a further + impact in low and high temperature scenarios, although the impact may also scale positively in high temperature scenarios, which when added to Option 1 results in: *Overall assessment of Option 2: ++ (low temp. scenarios) +++ (high temp. scenarios)*

Environmental impacts

Option 0 (Baseline)

Climate resilience: the key focus of the Adaptation Strategy is to improve climate resilience, in line with the overarching objective of becoming *'a climate-resilient society, fully adapted to the unavoidable impacts of climate change, with reinforced adaptive capacity and minimal vulnerability'*. The actions and measures of the 2013 Strategy were designed to address various aspects of this objective. The 2018 Evaluation of the Strategy examined progress against the three specific objectives rather than the overarching objective, and found that while substantial progress was being made, none of the three specific objectives had been fully achieved, a deficiency in climate resilience being one of the logical outcomes thereof. In the baseline scenario it is expected that similar deficiencies would remain, so that although some progress would be made in improving knowledge, reinforcing planning and taking

actions, the actions and measures of the 2013 Strategy would be insufficient to address the accelerating pace of climate change impacts and the need for action

Quality of natural resources/fighting pollution (water, soil, air etc.): climate change will have significant impacts on natural resources such as water, air and soil, which are each important for their functions for life, the economy, health and ecosystems. The 2013 Strategy attempted to address these impacts mainly through actions and measures to promote nature-based solutions, or through the assumption of co-benefits to natural resources from increased climate resilience. Particularly under its Action 2 of the 2013 Strategy, the LIFE and Horizon 2020 programmes included projects to pilot nature-based solutions, with benefits to natural resources. These types of projects and beneficial impacts would be expected to continue in the baseline scenarios. The broader co-benefits to natural resources from the Strategy would be quite indirect for most of the actions and measures in the 2013 Strategy, although there is particular scope for these to be further addressed in the baseline via Action 3 and consideration in the Covenant of Mayors of environmental quality and resource management at city and regional level; similarly, through Actions 4 and 5 to further research and its dissemination, and through Action 6 by mainstreaming adaptation into major EU spending programmes and projects. Opportunities for further development were identified in the 2018 evaluation, such as with coastal protection and green and blue infrastructure, but these would not be expected to be significantly addressed in the baseline.

Biodiversity, including flora, fauna, ecosystems and the services they provide and landscapes: Closely linked to the natural resources indicator, the main avenues to address this impact in the 2013 Strategy would be broadly the same, seeking primarily through Action 2 to address biodiversity and ecosystems as part of the projects supported by the LIFE programme, and more indirectly through the other actions. Whilst the baseline would continue actions in these areas and lead to better outcomes for biodiversity and ecosystems than no action, the co-benefits to this indicator would be limited.

Option 1

Climate resilience: the measures in Option 1 strengthen the Strategy and provide numerous additional ways in which the original actions can contribute to increased climate resilience by improving data, planning and management, and by supporting additional action by public and private stakeholders. Action 1 contains measures that focus on improving and harmonising monitoring, reporting and evaluation methodologies; by addressing these existing weaknesses it is expected that public authorities and others will be better able to identify issues and gaps in their planning and action, and to address these. Action 4 focuses on NbS, supporting their piloting, dissemination and deployment; these measures directly benefit climate resilience and often bring cost, social and environmental co-benefits. Action 5 can be particularly powerful at increasing climate resilience of cities and local authorities, with a mix of technical and methodological support, and reporting and funding requirements giving a significant boost to planning and action on climate resilience. Actions 1 and 2 are more indirect in their impact, but it is accepted that knowledge gaps are a major problem that stakeholders need to address; therefore, these Actions, with measures that address these gaps and weaknesses in multiple ways, are expected to empower many more stakeholders to take action. Action 6, by further mainstreaming adaptation in EU programmes in the context of the Green Deal and European Green Deal Investment Plan, would ensure increased availability of multi-billion funding streams to address climate resilience. Action 7 will improve guidance for climate resilient infrastructure and construction, and try to ensure these are used as widely as possible, particularly within EU funded programmes such as TEN-E and TEN-T; this will have an important benefit for long-term climate resilience for key infrastructure. Action 8, by

addressing the financial and public sector interface on climate resilience, is expected to increase the appropriate assessment, pricing and coverage of climate risk by these stakeholders, thereby increasing climate resilience.

The impact on climate resilience of the actions will be the same across temperature scenarios; the increased beneficial impact of the increased resilience in higher temperature scenarios is noted in the assessment of the other impact indicators. *Overall assessment of Option 1: ++*

Quality of natural resources/fighting pollution (water, soil, air etc.): the actions taken to promote climate resilience often have co-benefits for the wider natural environment and resources. Action 4 addresses the natural environment most directly, focusing on nature-based solutions for climate resilience, with the types of solutions to be piloted and disseminated having important benefits to natural resources. Action 5 contains measures that will bring broader environmental quality and resources into closer focus at city and local authority level. Other Actions and measures are also likely to bring indirect co-benefits for natural resources and pollution control. Nevertheless, the impact of Option 1 on this indicator is not assessed as large given the limited direct attention given to these impacts. The benefit of the Option is expected to increase with the temperature scenario, as the beneficial impacts on water especially would become more valuable. *Overall assessment of Option 1: 0/+ (low temp. scenarios) + (high temp. scenarios)*

Biodiversity, including flora, fauna, ecosystems and the services they provide and landscapes: the actions taken to promote climate resilience also often have co-benefits for biodiversity and ecosystems. The support within Action 4 for nature-based solutions can be expected to have beneficial impacts on biodiversity and ecosystems, as the use of these solutions over 'hard' infrastructure or solutions provides more hospitable, less damaging outcomes. The measures under Action 5, whilst bringing some benefit to environmental quality and resources at city and local authority level, do not address biodiversity and ecosystems as a headline objective. The other Actions and measures are likely to also indirectly have co-benefits for biodiversity and ecosystems. The benefit of the Option is not expected to significantly increase with temperature, as the beneficial impacts are quite small and indirect. *Overall assessment of Option 1: 0/+*

Option 2

Climate resilience: within Option 2 the international actions focus primarily on increasing climate resilience in partner countries, the benefits of which are assessed as part of the crosscutting impacts. Nevertheless, there are measures within these actions, particularly Action 11, that do focus on greater cooperation, exchange and learning for the EU from partner countries, with China, India and the Balkan countries identified. Actions 12, 13 and 14 have a stronger focus on climate resilience in the EU. Action 12 and the Mission on Adaptation is significantly geared towards the development and dissemination of knowledge for climate resilience, including through deep demonstrations, this can have an important impact. Action 13, addressing the climate protection gap, will better engage Member States finance ministries and in-turn other public authorities to review and improve their National Risk Assessments and to take actions to improve preparedness and protections. Action 14, focusing specifically on the water sector will also have an important impact on resilience. Overall, the climate resilience impact of this option is scored as a (+), added to Option 1, which results in an o*verall assessment of Option 2: +++*

Quality of natural resources/fighting pollution (water, soil, air etc.): the cross-boundary nature of natural resources means that the international actions taken by the EU under Option 2 can also lead to co-benefits for these resources in the EU. Actions 9 and 11 include

measures supporting partner countries in their adaptation actions and mainstreaming environmental and sustainability concerns into these, promoting ecosystem conservation and restoration as a measure to boost resilience and measures to boost environmental concerns in trade, each of which could indirectly provide co-benefits to natural resources in the EU. Action 12 includes measures that specifically focus on land resources, particularly forests and soils, with a focus on developing knowledge and innovations to improve the management and resilience of these resources. In addition, Action 14 provides for a dedicated set of measures to address water resources with a focus on improved, sustainable use and allocation of water, and in improved management in disaster situations to reduce contamination risks. The potential impact of these actions and measures is anticipated to be higher than Option 1, given the specific focus and targeting of sustainability and natural resources, and is scored as (+), increasing in high temperature scenarios to (+/++), added to Option 1, this results in an: *Overall assessment of Option 2 impact: +/++ (low temp. scenarios) ++/+++ (high temp. scenarios)*

Biodiversity, including flora, fauna, ecosystems and the services they provide and landscapes: similar to the previous indicator there can be benefits to the EU from the cross-boundary impacts of the international actions of this Option, but these are not expected to be as strong as biodiversity and ecosystems are more localised, and therefore the impact pathway is weaker. The co-benefits of international actions can provide for healthier ecosystems in the EU and the conservation of ecosystems in partner countries that can be part of EU species migration routes. The Mission on Adaptation in Action 12 includes an alignment with the EU Biodiversity Strategy and therefore the solutions to be implemented by this measure will provide benefits for ecosystems and biodiversity, particularly through the deployment of nature-based solutions. Action 14 on water resources includes a focus on securing environmental water flows and ensuring that environmental externalities are included in water pricing, both of which can be powerful instruments to benefit ecosystem quality and resilience. The potential impact of these actions and measures is anticipated to be higher than for Option 1, given the specific focus and targeting of biodiversity and ecosystems within actions 12 and 14, scoring a (+). In contrast to the assessment of option 1 and based on the more direct impact pathway of action 14, the benefits are expected to increase in high temperature scenarios to (+/++). Added to Option 1, this results in an: *Overall assessment of Option 2 impact: +/++ (low temp. scenarios) ++/+++ (high temp. scenarios)*

Cross-cutting impacts

Option 0 (Baseline)

Impacts in 3rd countries and international relations: The EU and its Member States have taken on greater international commitments on adaptation and climate change through various international treaties and programmes. For example, the EU and Member States are committed under the Paris Agreement to continuing to scale up the mobilization of international climate finance, as part of the developed countries' collective goal to jointly mobilize USD 100 billion per year by 2020 through to 2025 for mitigation and adaptation purposes. However, the 2013 Adaptation Strategy lacks alignment with these most recent international policy developments. It therefore has very limited international focus with few of the Actions having much more than minor avenues for international impact. In the baseline scenario, this would be expected to result in neighbouring and partner countries to the EU being less climate resilient than they would be with EU action. This has numerous implications, including in the political and diplomatic sphere, where the EU's global standing

could be reduced by lack of action in line with international treaties, and in the humanitarian sphere, as greater numbers of people would suffer as climate impacts increased.

Beyond this, the potential spillover effects on the EU can also be significant, from the economic impacts on trading partners reducing demand for EU goods and services, or the impact on international supply chains. Security and migration concerns are also relevant, as climate change could act as a threat multiplier and further exacerbate displacement of people, and increase the risk of conflicts. PESETA IV indicated that it is very challenging to assess these consequences, as detailed information is lacking. Other examples from sub-Saharan Africa, South Asia and Latin America, suggest that the changing climate is expected to displace more than 140 million people within their national borders by 2050[192]. In the baseline, there is a heightened risk of all of these impacts negatively affecting the EU and its partners.

Option 1

Impacts in 3rd countries and on international relations: this Option has very few measures that take a specific international perspective. Some international benefits could induced by the Option, for example through the changes in Action 3 to the Covenant of Mayors which includes non-EU cities and a Policy Support Facility which would include an international aspect; Actions 1 and 2 which provide data which can be globally useful; or Actions 6 and 7 which could mainstream climate resilience into funding and practice of EU programmes, including those spending outside the EU. Whilst the latter Actions in particular can be expected to have some impact, it is clear that only updating the existing actions of the 2013 Strategy does not significantly address the constraints and weaknesses of its international impact as identified in the 2018 Evaluation. As a result, the impact on developing countries is assessed as marginal, and as not significantly increasing with temperature scenario. Similarly, the positive impact on international relations is minimal; indeed the lack of action may lead to criticism of the EU, as well as increased humanitarian and emergency aid needs in third countries (which are already only partially met). *Overall assessment of Option 1 impact: 0/+*

Option 2

Impacts in 3rd countries and on international relations: one of the key aims of actions 9, 10 and 11 is to provide for a concerted set of measures to make EU international commitments on adaptation an effective and visible part of the new Strategy. Action 9 takes a strong focus on encouraging and supporting partner countries to improve their adaptation arrangements, including a focus on disaster risk reduction, risk and vulnerability assessment and strategy development. Action 10 is focused on the design of climate resilience supporting policies and instruments and in the financing of such measures to support their implementation, with the intention to use EU External Action and development aid to drive significant resources to the adaptation issue in partner countries, at the very least ensuring that EU spending in these countries is climate proof. Action 11 is intended to boost engagement and cooperation for mutual benefit of the EU and partner countries, this is an important diplomatic and political action, but can also bring practical lessons and benefits for all participants. There is a particular focus on developing countries across these actions, which is a natural focus given both the instruments to be used, the needs and the benefits for the EU. Actions 12, 13 and 14 have no specific international dimension. Overall, Option 2, with almost 20 proposed measures across three internationally targeted actions will already

[192] Rigaud, K. K., Jones, B., Bergmann, J., Clement, V., Ober, K., Schewe, J., & Midgley, A. (2018). Groundswell: Preparing for Internal Climate Migration. Washington, DC: World Bank.

significantly increase the impact of EU action compared to the baseline of near zero impact, and the Option 1 marginal impact. The actual impact to be achieved will depend significantly on the willingness of the partner countries to engage with the EU, but the benefits to both parties and the amounts of funding available through the targeted channels provides for a positive outlook for both the impact in partner countries and on the EU international relations. This option is scored for an impact of ++, with the benefits expected to increase significantly in high temperature scenarios to (+++). Added to Option 1, this results in an: *Overall assessment of Option 2 impact: ++/+++ (low temp. scenarios) +++ (high temp. scenarios)*

7. HOW DO THE OPTIONS COMPARE

This chapter presents the comparison of the options, as summarised in **Error! Reference source not found.**17.

Table 17: Summary of option comparison assessment

Indicator	Assessment		
	Baseline	**Option 1**	**Option 2**
Effectiveness	0/+	++	+++
Efficiency	++	+/++	+
Coherence	0/+	++	+++
Added Value	+	++	+++
Proportionality	+	+	++

Indicator	Assessment		
	Baseline	**Option 1**	**Option 2**
Effectiveness	0	+/++	+++
Efficiency	0	0/-	-
Coherence	0	+/++	+++
Added Value	0	+/++	+++
Proportionality	0	0/+	++

Effectiveness

The following section ranks the options in terms of their effectiveness in achieving the 4 objectives of the Strategy (see chapter 4). Firstly, we note that three of the four objectives bear a resemblance to the three objectives of the 2013 Adaptation Strategy. The new strategy has re-focused and increased the ambition of these objectives, and added a new fourth objective to strengthen climate resilience globally.

Option 0: continuation with the 2013 Strategy would only partially address the new objectives, as this option would not have more detailed measures and actions to achieve the higher climate resilience ambitions. It also would not address the fourth objective at all, and

this would be a significant deficiency. These deficiencies would become more apparent in higher temperature scenarios. *Option 0 overall assessment: 0/+*

Option 1: by significantly deepening the existing actions and measures taken over from the 2013 Strategy, this option would constitute progress compared to baseline as shown in the positive overall assessment of its impact on climate resilience. Yet Option 1 would not address the fourth objective at all. Furthermore, it would not take full advantage of the available knowledge instruments such as the Mission on Adaptation, nor would it fully address all aspects of the climate protection gap or sector level needs, which would reduce its potential to accelerate adaptation action. The lack of international actions would reduce the effectiveness of this option in higher temperature scenarios when greater global cooperation and resilience would be needed. *Option 1 overall assessment: ++*

Option 2: building on Option 1, this Option includes a suite of actions and measures that specifically address the fourth objective for global climate resilience, and additionally it also includes actions and measures which provide additional boosts to improving knowledge of climate impacts and solutions, through the Mission on Adaptation, and in addressing additional aspects of the climate protection gap and sector coverage. By addressing all objectives, this option has the greatest impact on climate resilience, and would be particularly beneficial in high temperature scenarios. *Option 2 overall assessment: +++*

Efficiency

As noted earlier in the assessment the Strategy imposes few additional mandatory obligations or costs on non-EC stakeholders. The actions and measures are primarily voluntary and provide assistance, support, knowledge, guidance, information and funding. Only in a few cases do the proposed actions lead to costs for non-EC stakeholders, by affecting markets or reporting requirements. In any case, the actions of the Strategy place an emphasis on maximising co-benefits for stakeholders and society as a whole. The main expenditures, which will require greater specification, fall upon the EC, with costs expected to be higher than the baseline for Option 1 and higher again for Option 2.

Option 0: the existing actions of the 2013 Strategy impose few mandatory costs on non-EC parties; this would not be expected to change. Therefore, whilst this option only partially contributes to the objectives, it does so cost-efficiently. *Option 0 overall assessment: ++*

Option 1: the modifications to the existing actions of the 2013 Strategy would lead to some additional spending by EC in various new programmes and initiatives. Cost estimates (see chapter 6 and Annex 7) show that these are not likely to significantly increase the costs of the Strategy. For example, the costs of the measure to establish a policy support facility (measure 5.4) are estimated at around €1.5 million. The move towards tying EC project funding to the development of climate resilience plans would increase costs for public and private stakeholders seeking EU funding, although the benefits of implementing the plans would be expected to offset these costs. Increased reporting and monitoring requirements would also increase costs for public authorities and a handful of financial sector stakeholders. Costs would therefore be somewhat higher than baseline, but as the option is likely to be much more effective, it remains quite cost efficient. *Option 1 overall assessment: ++*

Option 2: the additional actions of this Option address, largely, existing EC funds, e.g. in development aid, or Horizon research spending, therefore the overall cost impact is neutral. However, some of the new international actions and measures will require additional resources and efforts by the EC to initiate and maintain, and the actions on the climate protection gap will bring some additional reporting and engagement costs to Member States and private stakeholders. The expenditure and investments required by the EC are expected to

be low, but higher than for Option 1. Finally, the action on water is likely to have significant cost implications for users and the water industry. Overall, this option will cost the most, but also delivers the most. *Option 2 overall assessment:* +

Coherence

Option 0: the 2013 Strategy was evaluated in 2018 to be adequately coherent with other EU policies, but the developments in the policy context since 2018 such as the Climate Law and European Green Deal stand out. There is a risk that this coherence would be reduced over time and with insufficient flexibility within the Option to adjust to a changing policy environment. This Option would not provide alignment with EU commitments under the Paris Agreement and other international agreements. *Option 0 overall assessment:* 0/+

Option 1: the updated, deepened actions of Option 1 of the new Strategy would be much more aligned with EU policy developments since 2018, including through measures specifically designed to take advantage of and provide synergies with these developments. In a similar way to Option 0, the main gap would be in the area of international climate policy where the Option would not contribute to coherence. *Option 1 overall assessment:* ++

Option 2: in addition to the alignment with EU domestic policy noted for Option 1, this option would provide an important additional alignment and coherence with other European Green Deal policies (e.g. Biodiversity Strategy, Forest Strategy, Circular Economy Action Plan, Zero Pollution Ambition) and well as international commitments and external policy through the international actions. *Option 2 overall assessment:* +++

Added Value

Option 0: The rationale for EU added value was established and positively assessed in the 2018 evaluation: this would continue to be relevant, though the 2013 Strategy would become increasingly deficient in addressing growing needs for transboundary cooperation and contributing to EU international commitments. *Option 0 overall assessment:* +

Option 1: The updated, deepened actions would deliver more added value than the 2013 Strategy as shown in the effectiveness assessment; the improvements to the measures would in particular improve the EU level added value of transboundary cooperation and knowledge sharing. *Option 1 overall assessment:* ++

Option 2: The alignment of EU international action and addressing EU-wide problems through the Mission on Adaptation and its deep demonstration and other projects, and through sector-level measures such as Action 14, would provide significant additional EU added value compared to other options. *Option 2 overall assessment:* +++

Proportionality

Option 0: The rationale for the proportionality of EU action was established for the 2013 Strategy and positively assessed in 2018. No changes would be expected, except perhaps that the EU role could become disproportionately insufficient as climate impacts increase, particularly in the international area. *Option 0 overall assessment:* +

Option 1: The deepening of actions and increase of outreach to local and citizen level moves a step closer to what are usually regarded as Member State competencies, but remains within the bounds of what the EC can and should do, complementing national action. It does not impose significant new costs for public authorities and the voluntary and supporting nature of the measures leaves the major responsibility for action and freedom to act with the relevant national authorities. *Option 1 overall assessment:* +

Option 2: The additional international actions and measures increase the ambition of the Strategy and fall under the umbrella of EU competences for External Action. The other actions under this option also work proportionally under EU competences, through the Horizon Europe programme, and sector policy on water (e.g. developing EU competencies related to the Water Framework Directive). *Option 2 overall assessment: ++*

8. PREFERRED OPTION

Following the comparison of options in the previous chapters, **Option 2 emerges as the preferred option,** as it is the most beneficial across the assessed impacts and criteria taking account of the costs incurred and the expected benefits. In summary, Option 2 **(**the deepening of existing actions supplemented with novel actions) adds greater ambition to the Union's actions on climate change adaptation, in particular with regard to international actions. Novel actions that address the international dimension of the EU's adaptation policy are needed to progress on its objective to increase climate resilience globally. Moreover, international actions also contribute to the Adaptation Strategy's objective of 'improving knowledge of climate impacts and solutions' by providing for exchange and cooperation mechanisms to bring international innovations from partner countries to the EU. The other options do not address this important international objective, and would hamper the EU approach to adaptation.

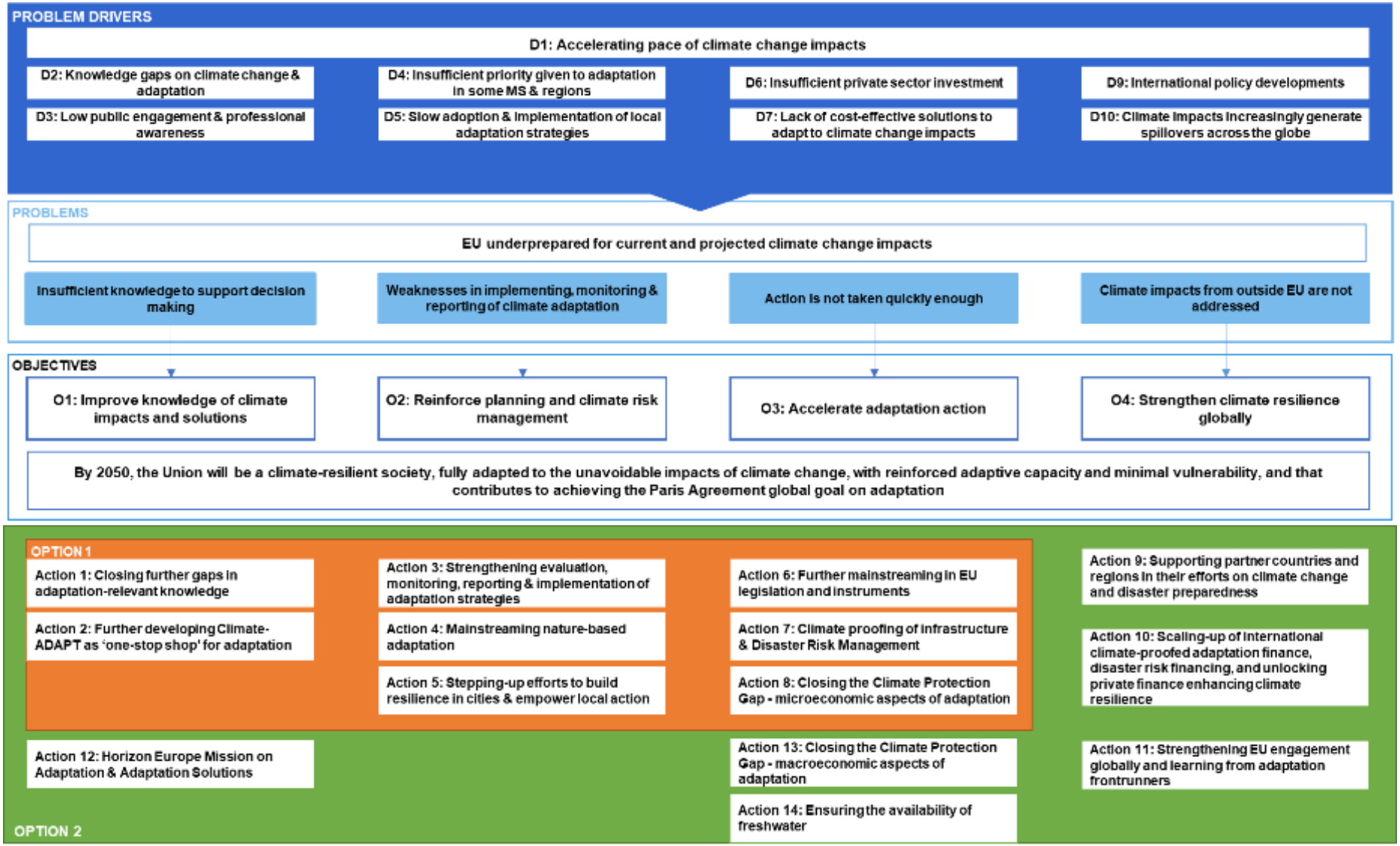
Option 2 also ensures that the EU's adaptation policies are aligned with broader EU policies and the Commission priorities resulting from the European Green Deal. New actions to reduce the climate protection gap and actions to increase transboundary cooperation address Just Transition policy and the need to "build back better" after the COVID crisis. Moreover, deepening actions to scale up private finance are aligned with the EU's Renewed Strategy on Sustainable Finance.

It follows from the summary tables in chapters 6 and 7 that option 2 does pose the highest costs to business compared to the baseline and option 1. Overall, the additional burden and costs to private stakeholders in the EU are estimated low, as few of the actions and measures impose mandatory measures. Furthermore, the negative impact of higher costs is mitigated in a few ways. Firstly, the Strategy provides a variety of guidance, support, data and funding sources for firms that can help them take action on climate resilience and reduce their exposure to damages. Secondly, this option has benefits across the whole macro-economic environment, reducing the volume of economic losses. Finally, the costs of the Actions under Option 2 (and 1) make use of existing funding infrastructure and knowledge platforms, such as Climate-ADAPT, the Covenant of Mayors and the ESF+, reducing new burdens. Overall, the additional costs are estimated proportional to the beneficial impacts achieved.

Similarly, the implementation of measures in option 2 may have some additional administrative costs. These will be measured in the future impact assessments for implementation of individual measures that will be announced in the strategy. We expect these costs to be low to moderate and to be largely outweighed by the benefits of adaptation action.

An intervention logic for the new EU Adaptation Strategy is presented below.

Figure 4 Intervention logic for the new EU Adaptation Strategy



9. HOW WILL ACTUAL IMPACTS BE MONITORED AND EVALUATED?

This impact assessment evaluates actions to further improve the resilience of the EU to the impacts of climate change. Many of the actions under Option 2 are action oriented and envisage immediate effects, while others anticipated to deliver their full effects in years to come. Monitoring will be required not only to assess whether the actions defined in the Strategy are on track but also to review the evolution of the global context and to determine whether additional new measures need activation. **The Adaptation Strategy is not a classical case for monitoring and evaluation** (neither for the baseline nor for the progress), the nature of its key objective 'climate resilient society' is not something that can be measured numerically. The long-term nature of both the problem being dealt with (climate change) and the impact of the measures does not lend itself to tracking and evaluating the impact of the Strategy.

Developments in adaptation tracking and indicators are somewhat limited, only a handful of countries in Europe have developed frameworks to track their adaptation. The existing systems focus heavily on indicators that track the early parts of the adaptation process, e.g. identifying climate change impacts and vulnerabilities, or on providing contextual indicators on how the impacts may be felt. Work in Member States provides some useful lessons to build on, and can help defining output and outcome indicators, that bridge the gap to impact indicators.

At EU level, the implementation of the Governance Regulation and the mandate assessment of progress as part of the Climate Law will provide an important new source of information for monitoring and evaluation of progress. This would add to, and enrich, the adaptation preparedness scoreboard exercise in 2017-2018, and the reporting under the Monitoring Mechanism Regulation in 2015 and 2019. First reporting under the Governance regulation will need to be assessed to consider how useful the information would be for evaluation the Strategy. Refinements to reporting templates can be made in the future to encourage MS to report the most useful information.

Indicators on public and private spending on adaptation can be valuable and can be improved, taking advantage of the Taxonomy and international tracking. The gaps in current data are addressed by actions in the Strategy and complementary policy initiatives. Tracking of international adaptation climate finance, i.e. towards the $100 billion adaptation fund goal, is currently more robust than most domestic public adaptation finance tracking. Lessons can be learnt and indicators may be developed in this area. The taxonomy offers potential for some simple tracking of spending towards adaptation.

Further development will be needed on the nature and purpose of indicators. Looking to build indicators for which a time-series can be developed and indications of progress can be made can already be an important step at this relatively early stage. Moving at a later stage towards indicators more closely tied to and relevant to objectives could be valuable. Caution also needs to be taken with numerical indicators, it is important to recognise that in many cases, counting is not enough (e.g. whether a Member State has a NAS), as this misses important issues and also potentially biases towards easy-to-measure, rather than relevant, indicators. Quantitative indicators must be contextualised with qualitative analysis. Work of the Global Commission on Adaptation will be useful for the definition of relevant indicators[193].

[193] See tables 1 and 2 especially in Leiter, T., Olhoff, A., Al Azar, R., Barmby, V., Bours, D., Clement, V.W.C., Dale, T.W., Davies, C., and Jacobs, H. 2019. "Adaptation metrics: current landscape and evolving practices". Rotterdam and Washington,DC. Available online at

Indicators should be re-used and repurposed from other sources and initiatives. Work for the Sendai Framework, or Sustainable Development Goals includes indicators that can be relevant for adaptation action, with the right contextual backing. Using these provides synergies and avoids re-inventing the wheel on some aspects. Ongoing work under the Strategy itself will be necessary to further develop the set of indicators for monitoring and evaluating the Strategy. This will need to take advantage of the various synergies that are possible and encourage a mutual learning environment with other stakeholders active in the adaptation indicator space.

The following **Error! Reference source not found.** provides a simple, illustrative first summary of some potential indicators for the Adaptation Strategy. While these examples for indicators focus on measures covered by mini-assessments (i.e. in Annex 7), a monitoring and evaluation scheme for the 2021, EU Adaptation Strategy will have to include the full portfolio (i.e. in Annex 6).

Table 18: Monitoring and evaluation indicators

Main objective	Specific objective	Action	Core indicator
By 2050, the Union will be a climate-resilient society, fully adapted to the unavoidable impacts of climate change, with reinforced adaptive capacity and minimal vulnerability, and that contributes to achieving the Paris Agreement global goal on adaptation.	**O1: improve knowledge of climate impacts and development of solutions:**	A1	Assessment of knowledge gaps by machine learning[194].
			JRC research: number of projects dealing with adaptation and budget allocated, disaggregated by regions
		A2	Use of Climate-ADAPT (e.g. number of visitors, pages most visited, number of registered users, assessment of the content, databases and metadata)
			Use of Climate-ADAPT – Health Observatory usage (e.g.: number of visitors, pages most visited, number of registered users, assessment of the content, databases and metadata) complemented by a qualitative assessment of fitness-for-purpose.
		A12	Horizon Europe and Adaptation Mission projects: number of projects dealing with adaptation and budget allocated, disaggregated by regions
			Horizon Europe and Adaptation Mission projects: detailed information resulting in tangible impact and the reduction of physical material risks
	O2: Reinforce planning and climate risk management	A3	Number of National Adaptation Strategies and Action Plans and climate change risk assessments,, including status of implementation (i.e. on full adaptation policy cycle) Number of Emergency Management Services risk and recovery maps produced for 'clients' in Europe
		A4	Number and amount of Life+ grants used for experience transfer on nature-based solutions.
		A5	Proportion of local and regional authorities that have an adaptation plan or strategy (e.g. through the EU Covenant of Mayors or similar initiatives)
	O3: Accelerate adaptation action	A6	List of policies and legal acts where adaptation has been mainstreamed (available)
		A7	Number of standards amended or developed coordinated by CEN/CENELEC, including the tracking of adopted standards by stakeholders
		A8	Tracking of non-financial disclosure (NFD) and in particular climate risk-related impacts in corporate social responsibility (CSR) reporting. Aligned with the EU Strategy on CSR
			Number of and total investment in adaptation infrastructure investments (co-) financed by EU funds and/or public financial institutions.
		A12	Amount of estimated climate-related insured losses.
		A14	Number of Water resource allocation established, including the assessment of regional and temporal scope

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[194] Biesbroek, R., Badloe, S., & Athanasiadis, I. N. (2020). Machine learning for research on climate change adaptation policy integration: an exploratory UK case study. Regional Environmental Change, 20(3), 1-13.

Main objective	Specific objective	Action	Core indicator
	O4: Strengthen climate resilience globally	A9	Monitoring Member State contributions by Adaptation Finance tracking in developing countries
		A10	Number of and total private investment in adaptation investments (co-) financed by EU funds and/or public financial institutions.
		A11	Number of commitments made by EU Member States to engage with other Nations to increase the bilateral exchange in knowledge and learning.

Annex 1: Procedural information

Lead DG, Decide Planning/CWP references

The Directorate-General (DG) for Climate Action was leading the preparation of this initiative and the work on the Impact Assessment in the European Commission. The planning entry was approved in Decide Planning under the reference PLAN/2020/7621. It is included in the 2020 Commission Work Programme under the policy objective "Commission contribution to COP26 in Glasgow ".

Organisation and timing

The planned adoption date (Q3 2020) included in the Commission Work Programme adopted on 29 January 2020, was changed to Q1 2021 in the revised version adopted on 27 May 2020 following the COVID-19 crisis. An inter-service steering group (ISSG) was established for preparing this initiative, as well as several thematic sub-groups.

Consultation of the RSB

A draft Impact Assessment was submitted to the Regulatory Scrutiny Board (RSB) on 4 November 2020. Following the Board meeting on 2 December 2020, it issued a positive opinion (with reservations) on 4 December 2020.

Several recommendations and feedback were made in the initial Impact Assessment Quality Checklist, which have been incorporated in the final Impact Assessment. These include the addition of a Glossary, indices of figures and tables, and a list of acronyms (in Annex 10). Also in response to the Board's feedback, several improvements and clarifications have been made throughout the text, for example in the way modelling results were reported, or how the expected degree of implementation of the proposed measures was integrated into the assessment. The introduction of section 6 further details the voluntary take-up of measures and compliance of parties – this is also expanded upon in Annex 7 for the mini-assessments. The macroeconomic costs and benefits are evaluated together as part of the economic (welfare) impact indicator, and the risks of higher damages are addressed by country in Annex 4 – with relevant deviations from the average effect also noted in the full assessment in section 6. The risks are also, importantly differentiated by temperature scenario (in section 6). Differences in regional damages in different temperature scenarios and over time, compared to expenditures influence the relative gain compared to baseline, in all scenarios there is positive change (as damages increase with temperature, gains compared to baseline increase). This is particularly relevant in Central Southern Europe (see Annex 4), where the timing and nature of damages means that option 1 impacts more effectively in the 1.5 degree scenario than in the 2 degree scenario - this was clarified in the report.

RSB Opinion 4 December 2020 [Ares(2020)7339457] – Positive with reservations

The Board notes the additional information provided in advance of the meeting and commitments to make changes to the report. In forming its opinion, the Board took into account that the impact assessment accompanies a high-level strategy, which raises particular challenges in terms of proportionate level of analysis. However, the report still contains

significant shortcomings. The Board gives a positive opinion with reservations because it expects the DG to rectify the following aspects:

(1) The report is not clear enough about what will be decided in this Strategy and which actions will require separate (legislative) follow-up. It does not sufficiently specify what actions should be taken at the EU-level, as opposed to national or local levels. It is not clear to what extent the listed actions refer to new elements, or whether they are part of other existing initiatives or programmes.

(2) There is a discrepancy between the positive outcome of the 2018 evaluation and the problem description that identifies a lack of preparation for climate change impacts.

(3) It is not clear what an appropriate degree of preparedness would be, taking into account the high degree of uncertainty on local climate change impacts.

The Board's recommendations have been addressed in the final version of the Impact Assessment as follows:

(1) The issues for decision in the Strategy have been clarified in the Introduction (Section 1.1), and the Options description (Section 5). These pertain to the political choices on the level of ambition, in line with the political mandate in the European Green Deal for a "new, more ambitious EU strategy".

The legal follow-up of certain of the actions, as well as the level at which these will be taken has been clarified in Annex 7 (per the respective mini-assessment of each relevant action). Several upcoming reviews (e.g. Urban Waste Water Treatment Directive) could see adaptation mainstreaming reinforced. For other processes, legislative follow up was not deemed necessary at this stage (e.g. there will be no revision of the Water Framework Directive following its fitness check, so climate change adaptation will be reinforced via guidance for the Common Implementation Strategy). Further work will require a pre-legislative follow up, such as white papers or blueprints, but also pilots of initiative (e.g. trying out a pilot on loss data collection before rolling it out in legislation).

Lastly, it has been clarified in Section 5, Policy Options, as well as the Annex 7 Mini-assessments that all proposed actions and measures considered as part of the macro policy options are referring to new elements, which would not otherwise be pursued. Several would, however, be launched other already established instruments, like Horizon Europe, but the level of detail would come in the programming stages, hence they would still be novel.

(2) The evaluation identified several shortcomings and room for improvement, in addition to its positive assessment of the Strategy still being fit for purpose. The discrepancy between the evaluation of the 2013 Strategy and the problem description justifying intervention for a new Strategy was clarified in Section 2 Problem definition. Throughout the text (mainly in Section 5, where the 2013 Strategy acts as policy baseline), the articulation between the 2013 Strategy and the new one has been further clarified.

(3) The adaptation gap is already large, as identified in global and European assessment reports, and getting larger (both because impacts are increasingly prevalent and because science is pushing our understanding of impacts e.g. on cascading impacts). This has been clarified in Section 5 when dealing with the macro policy options, as well as further developed

in Section 9 (monitoring and evaluation). The Paris Agreement global goal on adaptation is a dynamic one (i.e. enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change). As for any policy of disaster risk management (e.g. pandemics, earthquakes), success of adaptation action is often invisible because it constitutes averted damage (a counterfactual is difficult to construct). Dealing with climate impacts means dealing with complexity, uncertainty, tipping points, cascading risk – adaptation to these impacts therefore requires a dynamic implementation.

Annex 2: Stakeholder consultation – consultation synopsis

1. Outline of the consultation strategy

The ex-ante impact assessment of the new EU Adaptation Strategy supports the European Commission's efforts in updating the EU Adaptation strategy by: (1) Suggesting a range of policy options to achieve specific objectives; (2) Analysing the likely economic, social and environmental impacts of these options; and (3) Identifying the distributional aspects of adaptation across the diverse climates and regions of the EU.

The outputs of the consultation activities' form an important part of the evidence used to complete the impact assessment. Key objectives of the consultation process were:

- To ensure that all relevant stakeholders are identified and given the opportunity to engage with the consultation
- To provide the opportunity for stakeholders to inform the impact assessment, in particular, offering an opportunity for them to inform the development of policy options addressing the problems identified
- To gather stakeholder opinion on the potential policy options together with data and qualitative evidence concerning the relevant impacts of the policy options considered
- To draw insights into triggers for behavioural changes and other triggers supporting the take-up of adaptation measures
- To provide insights for short analytical topic reports that were also developed as part of the impact assessment process.

At the start of the impact assessment process, a comprehensive consultation strategy was developed in order to ensure that the stakeholder consultation was effective and useful. The consultation strategy helped to ensure that stakeholders' views were sought on all key questions in accordance with the requirements of the Better Regulation Guidelines.

Through various methods of engaging with stakeholders, the consultation informed the impact assessment by providing answers to the following questions:

- Are the problems identified in the previous strategy's evaluation exhaustive? Have other problems arisen which should be taken into consideration in the new EU Adaptation Strategy? (Problem to be tackled)
- What are other ongoing initiatives for adaptation at the local, regional, national and international levels? What is the EU added value to existing efforts? Are other platforms and/or levels of action more relevant for adaptation? Can the EU Adaptation Strategy's relevance and efficiency be threatened/enhanced by other actions and/or actors and/or events? Does the EU Adaptation Strategy conflict/align with other EU international engagements? (*EU dimension*)

- Based on the 2013 EU Adaptation Strategy, what other interventions are needed, and what are the policy options for these? Who should they reach? Where should the funding be sourced? When should they be triggered? Which, if any, existing policies are deemed redundant? (*Available policy options, scope for efficiency improvement, simplification measures*)
- Based on the 2013 EU Adaptation Strategy's evaluation, have other unintended impacts occurred since the evaluation and should be taken into consideration in the new EU Adaptation Strategy? Based on future temperature and climate impact scenarios, what policy implications can we foresee? How do those impacts and their magnitude differ within the population? Across businesses? Across Member States' borders? Across EU's borders? Across sectors of the economy? (*Impacts of the policy options*)

2. Consultation activities

The main consultation activities were the following: Open public consultation (OPC), Targeted stakeholder engagement through interviews, Public webinar, and online stakeholder workshops. Details of each of the consultation activities are provided below.

Open public consultation

An internet-based open public consultation was open for responses between 14 May 2020 and 20 August 2020, via the EC's EU Survey system[195].

The OPC began with an introduction to the consultation and an initial set of background questions about the respondent. The main body of the questionnaire contained 22 multiple-choice questions. These consisted of statements, and respondents were asked about either their familiarity with, or the perceived importance of, or their level of agreement with each of a set of statements, using a scale, which was subsequently converted to Likert-scales of 5 options[196]. The scales for all of the questions included 'opt- out' responses such as 'Do not know' or 'I am not familiar with'. This was to avoid agreement bias and to prevent respondents feeling pressured to give an opinion that they may not feel qualified to give or are uncomfortable providing. Finally, one open question at the end asked the respondent for any further relevant feedback, information or opinions they wished to share. Respondents also had the opportunity to upload any supporting documents (and were requested to summarise the main ideas of these papers).

Targeted stakeholder interviews

In order to gather more detailed feedback, targeted stakeholder interviews were conducted with key adaptation experts. In total, 40[197] interviews were undertaken with key stakeholders. Stakeholders were selected based on their field of expertise, their country of origin and in order to ensure coverage of a range of stakeholder categories. Categories represented include businesses; EU institutions, civil society/NGOs; research and academia; local authorities,

[195] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12381-EU-Strategy-on-Adaptation-to-Climate-Change

[196] The questions on extent of familiarity, importance and agreement with statements were accompanied by the possibility of selecting from a 0-5 scale (6-point). However, 6-point scales present interpretation difficulties, as a 'neutral' response is not available. In contrast, 5-point Likert
scales are more widely used and enable clearer interpretation of questionnaire results, measuring respondents' agreement with statements. For this reason, revised interpretation scales were agreed on with the European Commission and have been used in the analysis. Full details of the methodology that has been used are provided in Appendix 1.A.

[197] The 40 interviews are calculated as follows: A total of 31 interviews were conducted. Two interviews were organised as group discussions with multiple participants, who were intentionally interviewed for representing different Member States and thematic focuses. Given that each of those interviewees provided different inputs to each interview questions, their contribution was analysed as separate interviews. As a result, the total number of interviews feeding in feedback from stakeholders representing different organisations is treated as being 40.

regional authorities and national authorities; development banks and other international organisations.

The selection ensured a representative coverage of all geographical, thematic and stakeholder categories across the EU. The interviews were conducted between March and October 2020 and were sequenced as follows:

- 17 preliminary interviews were undertaken to provide general directions in support of the initial identification of the impact assessment policy options. These interviews also helped to test the interview questionnaire and the method.
- 18 main interviews were then targeted at stakeholders with specific expertise on the preliminary policy options identified.
- Finally, five final gap-filling interviews were undertaken to address any gaps identified in thematic, geographical or stakeholder coverage identified at the end of the "main interview stage" and to help finalising the impact assessment.

Public webinar

A public webinar was held for two hours, on 2 July 2020. This included presentations from key experts in the field, a panel discussion with these experts and a question and answer (Q&A) session with the audience. The event featured a presentation by the consultants on the planned method for impact assessment and the preliminary findings from the OPC. The webinar aimed to raise awareness of the development of the new EU Adaptation Strategy, the challenges it seeks to address and the added value of EU action. It was also used to promote the OPC to the audience.

Online stakeholder workshops

Interactive online discussions with targeted stakeholders took place in a two hour-long online workshop on 3 July 2020. This included breakout sessions to discuss potential policy options put forward by the consultants building on the Commission's Inception Impact Assessment (IIA).

A similar interactive online workshop was held on 7 July 2020, with members of the Working Group 6 (WG6) on Climate Adaptation of the Climate Change Committee of the European Commission. Breakout sessions were also organised to discuss the potential policy options put forward by the consultants building on the IIA.

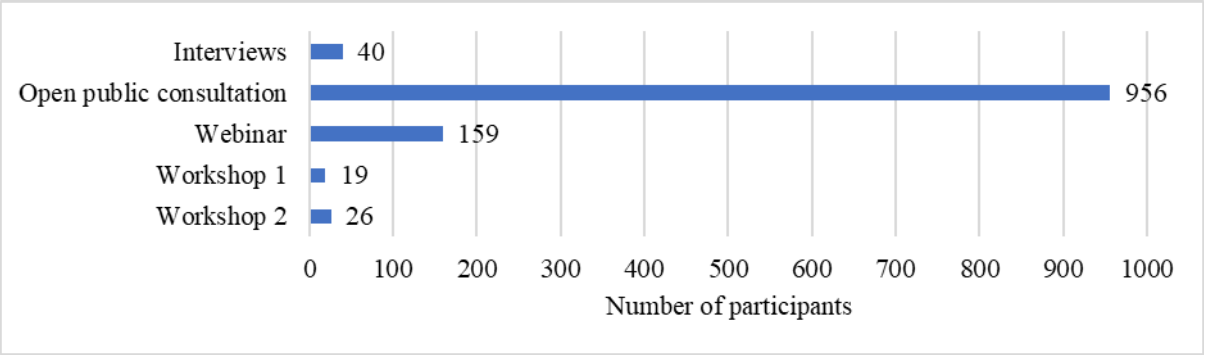
The two workshops allowed for discussion of the detailed policy options and the interactive discussions between experts and facilitators from the breakout groups sought to gather feedback and further suggestions on potential actions that could be included in the new Strategy.

3. Stakeholder groups participating

An overview of the audience reached across the stakeholder consultation activities is presented in the figures below. A comprehensive stakeholder mapping exercise was undertaken at the start of the impact assessment which helped to ensure that stakeholders who could be affected by the policy; will implement it; or have a stated interest in it were engaged.

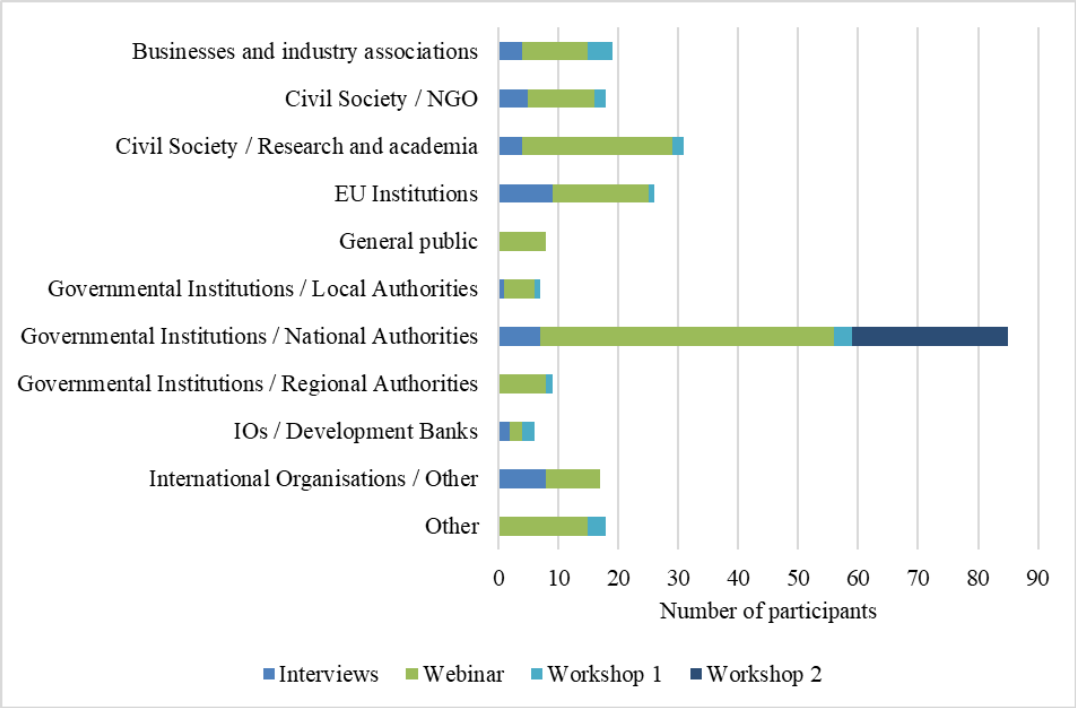
Figure 5 shows the total number of participants of each activity, while Figure 6 and Figure 7 show the share of participants by stakeholder type. Due to the pre-set tools used for the OPC, stakeholder categories have been defined differently for that consultation activity (Figure 7). Finally, Figure 8 shows the share of participants by Member State.

Figure 5: Number of participants by consultation activity



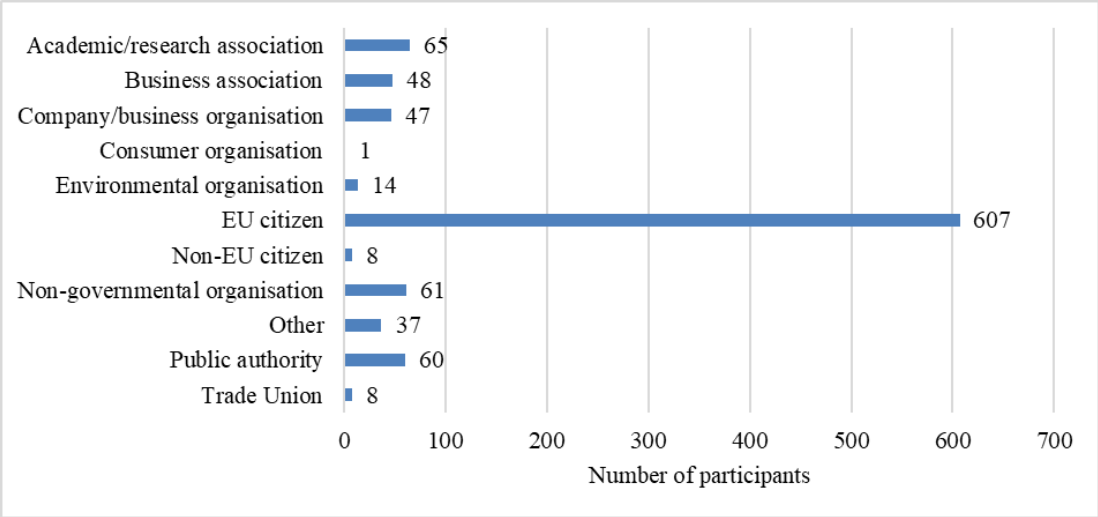
Source: Own analysis of participation by consultation activity

Figure 6: Participants by stakeholder type for the consultation activities (except OPC)



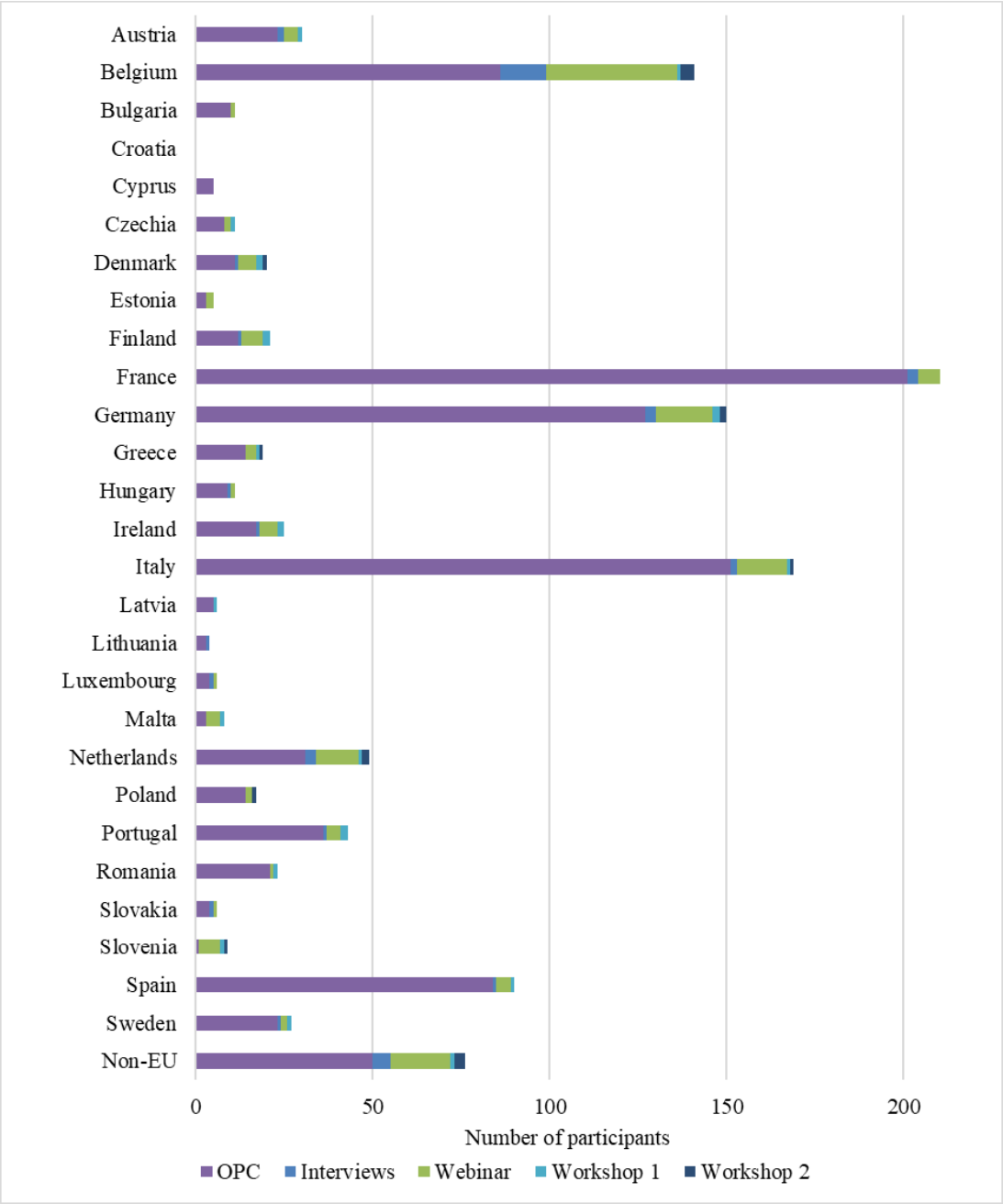
Source: Own analysis of participation by consultation activity

Figure 7: Participants by stakeholder type for the consultation activities (OPC only)



Source: Own analysis of participation by consultation activity

Figure 8: Participants by Member State for the consultation activities



Source: Own analysis of participation by consultation activity

4. Methodology and tools used to process data

Open public consultation

Questionnaire data was obtained from the European Commission Survey system. Data was inspected to allow adjustment if needed. For the final OPC data download, no significant update of formatting/data structure was required.

Questionnaire raw data was imported and cleaned using the Pandas library[198] to ensure consistency and repeatability. Graphics summarising the questionnaire results were then

[198] A data manipulation and analysis tool using the Python programming language.

created using an in-house survey analysis tool developed by Ricardo Plc based on Matplotlib charting library in python.

Qualitative information collected through the OPC was analysed through a labelling system in Excel. Those labels were identified based on the topics most covered in the respondents' answers to open text questions, and on their position papers' summaries. They are listed in the box below.

Box 19: List of labels representing most frequently mentioned areas of action

List of labels representing most frequently mentioned areas of action

Agriculture and fisheries; Air quality; Biodiversity and ecosystems; Businesses; Cities; Communication/ Citizen involvement/ Behavioural change (henceforth "Citizen communication and involvement"); Disaster risk reduction; Energy; EU Added value; Finance/ Funding; Forest; Health; Impacts; Infrastructure; Insurance; International dimension; Mainstreaming/ climate proofing/ integration of actions (henceforth "Mainstreaming/ proofing/ integration"); Monitoring/ reporting and guidelines; Nature based solutions; Ocean; Other; Regional approaches; Standards/ standardisation; Technology and knowledge sharing; Transport; Waste; Water.

Additional labels used to identify non-relevant responses: Emotive; Irrelevant; Mitigation focused.

In addition, the responses to the final open text question were systematically checked for overlapping responses to indicate possible coordinated replies by groups of respondents. Each question's open text answers were checked against all other open text responses in terms of their textual similarity by checking the cosine similarity of all answers against all other answers in python. This simple mathematical algorithm can be used to interpret text and is resilient to slight wording changes between similar answers. The algorithm was calibrated to identify similarities among any set of three or more responses.

Stakeholder and expert interviews and events

Trends identified based on the OPC analysis were verified against interview, webinar and workshop notes.

Interviews

A contact pool was developed in collaboration with the Commission to identify key stakeholders across all types of stakeholders and geographic regions. Some contacts were also reused from the evaluation of the 2013 EU Adaptation Strategy.

Prior to reaching out to the potential interviewees an interview questionnaire was developed which was tested as part of the preliminary phase of the interviews. The questionnaire was revised for the main and gap-filling interviews.

Stakeholders were contacted via the central email address and were invited for an interview, which was conducted via Microsoft Teams. In those cases where the interviewees agreed, the interviews were recorded in order to help the interviewer to better capture the discussion. Interview notes were taken and shared with the interviewees for approval.

Workshop and webinars

The webinar took place on GoToWebinar while the workshops were held through the Zoom platform, to benefit from the functionalities allowing breakout sessions, question and answer sessions, hand raising and polling features. An invitation to register was shared through the consultants' network and on social media. The stakeholders who were consulted during the

evaluation of the current Adaptation Strategy were also invited. Interviewees consulted as part of this impact assessment were also directly invited via email. Panellists for the webinar were selected, with the agreement of the Commission, to represent various stakeholder groups and governance levels.

Several test sessions were organised amongst the consultants and with DG CLIMA to ensure the functioning of the platforms. Detailed facilitators notes were developed for the project team to help the smooth running of each event.

All participants were required to register through a site hosted by the consultants, featuring a link to the consultant's privacy note[199]. In advance of the webinar, participants were sent background documents including the Blueprint for the new Adaptation Strategy, the Inception Impact Assessment and a link to the OPC. Similarly, a concept note was shared with participants in advance of the workshops. After the events, presentation slides and recordings were disseminated to attendees and workshop notes were sent to the panellists for approval.

5. Results of consultation activities

For each element of the impact assessment (problem drivers and problems, objectives and actions, and impacts), we first present the most relevant results from the OPC, identifying the answers that have received the most and the least support. When presenting those results, we identify the percentage of responses in relation to each answer. We then compare the OPC results to inputs received from the experts interviewed and the workshops, identifying key similarities and differences. Unless specified otherwise, inputs from interviews and workshop is reported in this section when it represents the views of the majority of participants and interviewees.

Additional individual inputs and inputs provided by a minority of stakeholders are recorded in the appendices accompanying this consultation synopsis: full details of the analysis of the OPC results are provided in Appendix 1.A. An overview of the stakeholder interviews is presented in Appendix 2.A. While notes from the stakeholder events are provided in Appendix 3.A. A full list of accompanying appendices is provided at the end of this annex.

Problem drivers and specific problems identified for the new EU Adaptation Strategy

Results from the OPC

Problem drivers: climate change

According to their responses to the OPC[200], stakeholders have most often experienced ***seasonal shifts*** (94.8%), *abnormally* ***warm overall temperatures/droughts*** *during one or more seasons* (93%), and ***heatwaves*** *causing health problems and death among the vulnerable* (74.8%). Water-related events, such as a *reduction in water availability* (60%) and *river and coastal floods* (70%), were less reported in the survey. Most of the respondents have not experienced the *disappearance of glaciers' long-lasting snowfields* (54.6%[201]), *seaside storm surges* (47.2%), *intrusion of seawater in freshwater aquifers* (44.2%) and *emergence of tropical diseases* (42.5%).

These results may reflect the fact that *seasonal shifts* and *warm overall temperatures/droughts* can be easily and/or frequently witnessed by the respondents, or that they tend to associate

[199] https://ee.ricardo.com/climate-change/impact-assessment-for-the-new-eu-adaptation-strategy

[200] See Figure 3-5 and Figure 3-6 in Appendix 1.A accompanying the consultation synopsis presenting the analysis of the OPC.

[201] Percentage refer to the proportion of respondents that have provided a negative answer to the specific statement (here, "disappearance of glaciers' long-lasting snowfields")

those events with climate change more. *Heatwaves* and *river and coastal floods* are less witnessed, or less associated with climate change. The low reported experience of coastal-related events (*seaside storm surges*, *intrusion of seawater in freshwater aquifers*) and of the *disappearance of glaciers' long-lasting snowfields* and the *emergence of tropical diseases* may be a reflection of the geographical representation of the respondents, assuming that they are more likely to witness those impacts if they live near a coast, glaciers or in tropical areas. As the five most represented Member States[202]all have coasts, these low reporting rates may also imply that respondents do not associate these events with climate change. Coastal events were reported as important threats by participants in both workshops and by interviewees.

Problem drivers: EU level

Most of the respondents considered that the ***growing speed of climate impacts*** is a "very important" driver for the new EU Adaptation Strategy (75.5%).[203] According to them, the following factors should also drive the definition of the new Strategy: a ***lack of interest*** *in climate impacts in some Member States or regions* (57.7%), ***insufficient public finance*** *for adaptation to climate change* (55.2%), ***insufficient public awareness*** *of the need to adapt to climate change* (51.4%), ***insufficient private sector investment*** *and action on adaptation* (44.4%) and ***unclear distribution of responsibilities*** *between levels of governance* (40.6%). The driver with the lowest number of 'Very important' responses was *insufficient science/ knowledge on climate risk assessment for adaptation* (30.3%).

Specific problems at the EU level

Over half of the respondents strongly agreed that *financial support for adaptation to climate change is insufficient* (53.1%), indicating that the amount of financial support currently available is seen as not matched to the needs, implying that that more funding is needed.[204] Other problems were reported, receiving scores in the 45% to 48% range. This includes: ***weak implementation*** *of adaptation strategies and plans* (48.3%), ***insufficient mechanisms and indicators to monitor and report*** *on the implementation of adaptation strategies and action* (47.5%), ***unclear alignment between the EU Adaptation Strategy and international policy developments*** (45.2%) and a ***lack of appropriate involvement of businesses and the financial sector*** *in adaptation efforts* (45.2%).

Out of all suggested specific problems, the *2013 EU Adaptation Strategy's predominant focus on the EU may have been a problem preventing adaptation action* is the statement that most stakeholders strongly disagreed with (5.1%).

Similarities and differences with feedback from other consultation activities

Problem drivers: climate change

An important difference between OPC respondents' reports of most-experienced events and those of contributors to other consultation activities was their appreciation of **water- related events**. While OPC respondents seem to have experienced these climate-related events less than other events, the majority of interviewees and workshop participants referred to coastal erosion, flooding, saltwater intrusion and lack of water availability as some of the most important slow-onset changes caused by climate change in Europe. This was due to the substantial proportion of the European population which is coastal (including in the outermost regions), and the importance of water availability for agriculture. River flooding was also

[202] Belgium, Germany, France, Italy, Spain.
[203] See Figure 3-11 in Appendix 1.A accompanying the consultation synopsis presenting the analysis of the OPC.
[204] See Figure 3-12 in Appendix 1.A accompanying the consultation synopsis presenting the analysis of the OPC.

mentioned by interviewees as an important security concern for the large share of the population living close to rivers.

In contrast, seasonal shifts, which were considered by OPC respondents as the most experienced event, were not reported as much by interviewees and workshop participants as a specific climate-related event causing concern. Only one interviewee (a civil society expert) highlighted that this was an element that could not be controlled, and which would drive the impacts of climate change.

These differences in perception of the "most experienced climate-related events" may illustrate a lack of information and awareness on climate impacts and costs among the wider population, an issue reported by the majority of workshops and interview participants.

Finally, interviewees and workshop participants highlighted strong diff**erences in vulnerabilities across Europe.** While most acknowledged that all geographical regions will be impacted, they indicated that they will be impacted differently. Interviewees and workshop participants across all stakeholder groups highlighted that some regions are more vulnerable than others and, hence, there is a need to identify and prioritise vulnerabilities. Overwhelmingly, Southern Europe and Mediterranean regions were reported as the most vulnerable regions, though Central and Eastern Europe were considered increasingly vulnerable. Northern Europe was considered less vulnerable, though changing ecology and forest systems are anticipated. EU citizens were also perceived as varying in their vulnerabilities depending on their occupation, gender, access to services and wealth.

Problem drivers: EU level

The main challenges identified by respondents to the OPC were also largely reported throughout the other consultation activities. In particular, the **lack of knowledge and awareness** was reported by almost all workshop and interview participants from all stakeholder groups. This is characterised by a lack of knowledge at the policy-making level, and at the level of individual citizens. Interviewees and workshop participants representing national and local authorities, civil society businesses and international organisations felt that the **EU should play a key role in facilitating knowledge sharing at all levels of governance, between countries and within them**.

At the policy-making level, the lack of knowledge and awareness of climate change adaptation most likely stems from a **lack of access to available and usable knowledge and data** reported by most participants. Like the OPC respondents, the majority of participants from all groups to the workshops and interviewees considered that there is enough existing data and knowledge. However, they reported problems in its **format, standardisation, and accessibility**, particularly at the local level. According to many interviewees and workshop participants from all stakeholder groups, challenges arise from the:

- Lack of relevance, granularity, and usefulness of the existing data for local situations, and
- Lack of common methods of monitoring adaptation action at MS and EU levels as decision-support tools.

At the level of citizens, a **lack of information on the costs of inaction and unpreparedness** prevents necessary behavioural change, according to some interviewees (representatives from business organisations, international organisations and civil society organisations). The need to increase awareness and peer-to-peer learning about co-benefits was also raised by all stakeholder groups during the workshops.

Overall, according to interviewees and workshop participants, the main knowledge gap to be bridged is the one between decision-makers, practitioners and researchers. This problem was

widely reported among international organisations and civil society. Other knowledge gaps reported by stakeholders across all stakeholder groups are gaps between EU Member States, with countries internationally, and vertically between levels of governance.

Specific problems at the EU level

A frequently reported barrier was the weak implementation of adaptation action, sometimes perceived by participants as "**Member States inertia**". More specifically, participants mainly from international organisations and civil society representatives pointed to the lack of formal commitments to adaptation (especially in comparison to mitigation commitments), the lack of clear political targets and commitments, the lack of mechanisms and indicators to monitor and report implementation, and the lack of alignment of standard practices. Some stakeholders, including civil society representatives but also stakeholders from EU institutions considered that this lack of implementation may result from the **lack of binding laws and/or constraints or from the lack of centralised knowledge to build political case for adaptation**. During the workshops, implementation in Member States was also discussed, with specific attention on how it should be monitored and reported. Participants in all consultation activities expressed an interest in the EU providing consistent guidelines and indicators for monitoring and reporting on adaptation.

A **lack of funding** was also identified by several interviewees (representing business organisations, civil society, EU institutions, local authorities, national authorities and international organisations) as a barrier to adaptation in the EU, though it was suggested that this may not be due to differing priorities and commitments. During the webinar, a panellist from an international organisation highlighted a further challenge to funding: ensuring that it trickles down to all sectors and can be leveraged to increase resilience. Overall, lack of funding was discussed less during interviews and workshops than implementation by Member States and the availability of knowledge and data. However, an interviewee from EU institutions identified the importance of **making more funding available to implement measures at the local level**, which is consistent with further feedback received from the workshops and the OPC.

Overall, interviewees and workshop participants highlighted the following additional challenges, which were not reported by OPC respondents (challenges are listed in order from the most to least reported):

- Insufficient consideration for the **international dimensions of climate change adaptation**. According to many interviewees and workshop participants, the current strategy looks inward rather than also outwards. As a result, both interviewees and workshop participants reported a lack of focus on spill-over effects of adaptation (citing supply chain disruptions, climate migration, etc.), insufficient EU support for adaptation in third countries, and a missed opportunity to share knowledge globally, including learning from third countries currently experiencing more severe impacts.
- Insufficient coherence of adaptation across EU policies. Workshop participants and interviewees particularly mentioned the Common Agriculture Policy (CAP) and Cohesion Policy. Other policies reported by interviewees as lacking coherence with adaptation objectives included the Water Framework Directive. Lack of consideration of potentially **conflicting actions across such policy areas that could lead to maladaptation** was pointed out by interviewees and workshop participants.
- **Lack of certainty** in the projections of climate impacts. According to workshop participants, prospects of acting on uncertainty may be causing inertia. An interviewee highlighted the need for a more proactive approach and the importance of preparing and planning before adverse impacts arise.

- **Disconnect between climate change and climate security** in European public discourse. A few participants reported that that the security impacts of climate change mainly affect vulnerable populations in poor countries, but that this is not a sustainable view.
- Insufficient focus on **ecosystem-based adaptation and nature-based solutions**, including in the CAP.
- **Lack of long-term planning**. Current action plans and policies were reported as tending to be very short term, whereas adaptation also demands consideration of longer time horizons (20-50 years).
- Insufficient **differentiation between slow onset and extreme weather events**.
- **Too much focus on cities** rather than local action more generally, as there is a need to increase local resilience and, thereby, reduce inward migration to cities.
- An **insufficient focus on the adaptation-mitigation nexus**. Some interviewees highlighted that mitigation and adaptation should be considered as an overarching synergistic objective.

While drivers of, and challenges to, the new EU Adaptation Strategy were not explicitly discussed in the workshop, the challenges identified above were raised in the context of the EU Adaptation Strategy's existing actions and the need for new actions. Hence, they are also reflected in the results presented below.

Objectives and actions of the new of the new EU Adaptation Strategy

Results from the OPC

Identification of objectives

According to OPC respondents, it is most important for the new EU Adaptation Strategy to be aligned with the following EU and international policies: **The Paris Agreement** (71.8%), the **European Green Deal** (69.4%), the **UN Sustainable Development Goals** (62.2%) and **the UN Convention of Biological Diversity** (60.0%)[205]. Fewer respondents rated the Sendai Framework for Disaster Risk Reduction and the EU Civil Protection Mechanism as important. This may indicate less concern for, and/or awareness of, the immediate security issues needing to be addressed by climate change adaptation and an insufficient appreciation of the "virtual certainty" (IPCC AR5) of the increasing frequency and magnitude of extreme events as global mean temperatures rise.

Most respondents strongly agreed that an ***increased focus on implementation*** *(in addition to planning)* is also needed (74.9%).[206] The objective to ***increase focus on innovation (in addition to research)*** **had the lowest number of 'Strongly agree' responses** (52.2%). This echoes respondents' identification that enough knowledge and solutions are available to adapt to climate change now, indicating no need for further innovation and planning, but rather a need for financing and action.

Among more specific objectives, most respondents strongly agreed that ***the EU should support Member State-level action on adaptation*** (59.3%).[207] EU support at the local level also received strong support, though less than support at Member State level.

[205] See Figure 3-10 in Appendix 1.A accompanying the consultation synopsis presenting the analysis of the OPC.
[206] See Figure 3-13 in Appendix 1.A accompanying the consultation synopsis presenting the analysis of the OPC.
[207] See Figure 3-14 in Appendix 1.A accompanying the consultation synopsis presenting the analysis of the OPC.

Respondents indicated that the lack of private sector investment and action on adaptation should be a driver of the strategy. However, *EU support to private sector action on adaptation* received the least support from respondents (33.1%). This may imply that respondents would prefer to see public investment and actions compensate for the lack of financing from private sources, rather than the EU Adaptation Strategy supporting its development.

Identification of actions

Existing actions

Respondents mostly identified the **water, agriculture, energy, and transport sectors as well as ecosystems** as requiring further action for sustainable adaptation to climate change.[208] Most of them neither agreed nor disagreed with implementing further action in the insurance and finance sector, supporting the previous conclusion on the importance of public action to make up for, rather than support, private actions.

Respondents agreed that all actions of the 2013 EU Adaptation Strategy should be "retained and reinforced"[209].[210] ***Action 1: Encourage all Member States to adopt comprehensive adaptation strategies***, received the highest level of support from respondents (74.2%), which reflects responses received strongly agreeing with the objective to support Member State-level action on adaptation. The action that fewest respondents suggested continuing was *Action 8: Promote insurance and other financial products for resilient investment and business* (9.6%). This may be due to a lack of awareness of it, as indicated in the previous answers. It may also result from most insurance products only covering a narrow range of climate-related risks, as indicated by EU citizens, businesses and NGOs alike.

Potential new actions

All potential actions for a new EU Adaptation Strategy suggested as part of the consultation were considered important by respondents. The action that was considered "very important" by most of the stakeholders was to ***support the resilience of agriculture and forest ecosystems*** (65.2%), which reflects the priority sectors identified previously.[211] In addressing this action, ***nature-based solutions and diversification of systems*** were considered the most important elements for climate-resilient agriculture and forests by the respondents.

The second highest level of support for an action was for ***more open access to climate loss and disaster risk data*** *from private and public sources* to allow all actors to take an active role in adaptation action and to help integrate climate risks in decision-making (51%). Hence, while stakeholders previously replied that knowledge and data already exists, they indicated here that this data may not be sufficiently available. In another question, the majority of respondents indicated that, out of all the stakeholder categories, citizens should have the greatest priority for ***easier access to asset-specific information about the physical and economic damage from past climate related disasters*** (101/133), then local authorities (94/133).[212]

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[208] See Figure 3-16 in Appendix 1.A accompanying the consultation synopsis presenting the analysis of the OPC.

[209] Currently, the actions of which the respondents were least aware of are actions pertaining to awareness raising on the availability of insurance
options against climate change damage (56.8%), the increase of green areas in towns to cope with heatwaves/floods (56.2%) and reinforcement
of infrastructure to better withstand natural disasters like floods, heatwaves etc. (48.8%).

[210] See Figure 3-15 in Appendix 1.A accompanying the consultation synopsis presenting the analysis of the OPC.

[211] See Figure 3-17 in Appendix 1.A accompanying the consultation synopsis presenting the analysis of the OPC.

[212] See Figure 3-23 in Appendix 1.A accompanying the consultation synopsis presenting the analysis of the OPC.

All the other actions were considered as ‘very important’ though without a clear majority. S*upporting resilience investments and natural disaster insurance penetration through EU* and *MS policies and helping to identify health and/or social risks linked to climate change* (39.2% each) received the least support from respondents.

Similarities and differences with feedback from other consultation activities

Identification of objectives

Overall, the majority of interviewees and participants in the workshops agreed with the objectives of the current strategy, and suggested the following enhancements:

- *Objective 1 – Promoting action by Member States* - While recognising the importance of supporting Member States, most interviewees and workshop participants **highlighted the importance of supporting adaptation at the local level, including by supporting local authorities**. Several interviewees also highlighted the importance of **promoting local action beyond cities,** one pointing to the need to increase local resilience and, thereby, reduce inward migration to cities.
- *Objective 2 - "Climate-proofing" action at EU level*: Interviewees and workshop participants overwhelmingly emphasised the need to ensure coherence and synergies with other key EU policies.

  Beyond "climate proofing", **mainstreaming of adaptation issues in all policies was considered by all stakeholders to be a key objective of the new strategy**, to ensure that all policies' actions are aligned with adaptation objectives and, where possible, conducive to resilience. While the Green Deal was considered as a welcome step for adaptation by many interviewees, the vast majority highlighted the importance of ensuring coherence across policy areas, in order to direct investments towards climate-friendly objectives and prevent maladaptation.

  In particular, the Common Agricultural Policy and the Water Framework Directive were mentioned by many participants. Interviewees and workshop participants alike identified that both policies can currently lead to funding that may be contradictory to adaptation objectives.

- *Objective 3 – Better-informed decision making*: **promoting better-informed decision-making** was recognised by all participants as a key objective to be maintained and expanded, in particular, through **ensuring standardised knowledge- and implementation-sharing platforms**.

While interviewees and workshop participants agreed with the existing objectives, participants also suggested adding to them. Two new objectives were suggested by a large majority of interviewees and workshop participants across all stakeholder groups:

- An "**outward-looking" objective** to recognise the international dimension of adaptation, enable global knowledge sharing, local-to-local knowledge sharing between locations facing similar challenges, support to enhance adaptive capacity in third countries and other preparatory actions to counter spill-over effects from climate-related events elsewhere affecting Europe.

  Given the importance of such an international dimension, this has been considered as a new objective for the new Adaptation Strategy under the Impact Assessment; therefore more detail on the comments received from stakeholders on this issue is provided below.

- A "**citizens-focused" objective**, dedicated to ensuring that citizens are more aware of climate change impacts and associated costs, as well as the opportunities presented by adaptation, and that they feel empowered to take adaptation actions.

Box 20: The international dimension of the new EU Adaptation Strategy

The international dimension of the new EU Adaptation Strategy

Open public consultation

77% of the OPC respondents agreed or strongly agreed that "*the EU should support internal action on adaptation*". When asked for"any further information that [they] believed would be useful for preparing the EU's new Adaptation Strategy", 17 OPC respondents provided further comments supporting an international dimension for the new EU Adaptation Strategy. These included the following points:

- Two stakeholders from academic and research institutions highlighted that "*it is also important to adapt to risks cascading on Europe though trade, financial and political network" and that "it is important to develop innovative technological tools […] not only pertaining to the European Union, but also to the global extent and certainly developing countries*."
- Two representatives from public authorities highlighted that "*transnational collaboration is key and further efforts are needed*" and that "*international adaptation should also include adaptation in countries outside Europe where climate change could lead to large scale economic damage or starvation, with subsequently social unrest and conflicts which also could lead to large scale migration*".
- Among others, an NGO also provided the following statement: "*We strongly recommend the EU external relations be included and addressed in the strategy beyond climate security. […] The EU should address the global challenges of climate change adaptation, disaster risk reduction and environmental degradation as a priority through its bilateral and multilateral relations, sending a strong signal to the rest of the world on the importance of prioritising adaptation planning and investment. We encourage the strengthening of international and regional cooperation on climate (and disaster) resilience, including attention to cross-border risks.*"
- An EU citizen has also highlighted that "*governments should also cooperate, and not only within the EU. […] The new Strategy should have a strong international dimension, as shown with the current COVID crisis*."

Additional material submitted

In addition to the responses to the OPC, the international dimension was also apparent in additional materials submitted by stakeholders. 25% of all position papers and other documents submitted via the OPC or received directly via email or following experts' interviews highlighted the importance of the international dimension in the new EU Adaptation Strategy. Among them, **48% of all public authorities, 25% of all academic and research institutions and 13% of all companies, business organisations and association** who submitted papers across all channels highlighted this. Additional material received which highlighted the international dimension was submitted by stakeholders from 17 different countries, and mainly from France, Belgium and Germany.

Interviews and stakeholder events

When questioned about the existing and new actions of the new EU Adaptation Strategy,

the need to strengthen the international aspect of actions and/or to develop a new internationally focused action was brought up by interviewees in 12 out of 31 interviews. Interviewees from EU institutions, international organisations, businesses, and NGOs alike highlighted actions in two potential spheres internationally: (1) "*addressing spill-over effects"* and (2) "*assisting other countries to adapt (particularly least developed countries)".* International actions were suggested in specific areas including knowledge sharing, disaster risk reduction, security, mainstreaming and development aid.

The same conclusions were drawn during stakeholder workshops, where the global component was welcomed and highlighted as a very important element. Representatives from different Member States across the Working Group 6 emphasised that global action needs to be reinforced and further developed in the new Strategy. It was considered by one participant as the most important improvement to the strategy, alongside the health observatory.

Identification of actions

Existing actions

No participants in any of the consultation activities suggested discontinuing any of the current EU Adaptation Strategy's eight actions. Instead, they overwhelmingly suggested there was a **need to expand** them, as discussed below.

Action 1 – Encourage all Member States to adopt comprehensive adaptation strategies: All interviewees and workshop participants agreed that this should be **reinforced through the development of standardised monitoring and reporting guidelines**. In particular, participants in the Working Group 6 workshop representing national authorities highlighted that Member States are insufficiently aware of the current progress of adaptation implementation, partly because of lack of monitoring, partly because of the very nature of adaptation, where actions such as flood risk management are not systematically labelled as "adaptation". To support Member States further, many interviewees and workshop participants also mentioned the need for the EU to facilitate cross-country knowledge exchange.

In a similar way to the OPC respondents, interviewees overwhelmingly supported the **need to move from planning to more implementation**. Some workshop participants representing Member States also highlighted that the focus on implementation of the National Adaptation Strategies and/or National Adaptation Plans should be strengthened, moving away from "planning" only. In general, they supported a focus on implementation, while noting associated challenges.

- *Action 2 – Provide LIFE funding to support capacity building and step up action in Europe:* LIFE funding was considered by most interviewees and workshop participants (including EU institutions, international organisations and national authorities) as insufficient by itself to support climate change adaptation. They supported the need for greater funding and capacity building within but not only through LIFE but also through existing sectoral actions, including the CAP, the Cohesion Policy etc.
- *Action 3 – Introduce adaptation to the Covenant of Mayors framework:* The majority of interviewees and stakeholder participants supported the Covenant of Mayors and suggested that this action should be expanded to support adaptation

action at the local level more generally. To this end, interviewees and workshop participants alike highlighted that the Covenant of Mayor's mandate could be expanded to support adaptation not just in cities, but also to **support resilience in non-urban areas and/or at regional level,** and to **support knowledge exchange across governance levels and between cities.**

- *Action 4 - Bridge the knowledge gap:* Like OPC respondents, more open access to climate loss and disaster risk data received some support from other consultees, in particular, during the workshops with national authorities but also according to civil society, international organisations and businesses representatives. However, this was mainly considered as a support for engagement from the private sector by enabling the estimation of gains and losses from climate change adaptation and inaction within relevant sectors. This also reflects calls to enhance knowledge exchange across practitioners and to provide more standardised data.

  Most importantly, almost all interviewees and the majority of workshop participants from all stakeholder groups indicated that **the knowledge gap that needs bridging is the one between decision-makers, practitioners and researchers.** To close this gap, they highlighted the importance of "learning-by-doing" as a means of knowledge sharing.
- *Action 5 – Further develop Climate ADAPT as the 'one-stop-shop' for adaptation information in Europe:* While not all stakeholders were familiar with the platform, the majority of interviewees across all stakeholder groups suggested enhancing the role and reach of climate ADAPT to address the knowledge gaps identified in Action 4.
- *Action 6 – Facilitate the climate proofing of the Common Agriculture Policy, the Cohesion Policy and the Common Fisheries Policy*: Most interviewees and workshop participants, including members of Working Group 6 representing national authorities, reported that there was a need for further mainstreaming of adaptation objectives across these policy areas, particularly in relation to the CAP, which it was suggested was potentially working against adaptation objectives and promoting maladaptation.

  Interviewees and workshop participants, including Working Group 6 participants representing national authorities, suggested **expanding this action to include mainstreaming and implementation of adaptation action through all EU instruments**, with the Water Framework Directive often specifically mentioned. Other suggested policies for mainstreaming included: European Pillar of Social Rights; EU Skills Agenda; EU Cohesion Policy; EU Gender Equality Strategy; Non-Financial Reporting Directive.
- *Action 7 – Ensuring more resilient infrastructure*: While this action was less discussed by interviewees and workshop participants than the other actions, the majority of them highlighted the importance of making greater use of green infrastructure and nature-based-solutions, implying that this action should also be expanded.
- *Action 8 – Promote insurance and other financial products for resilient investment and business decisions:* While this action was the least supported by OPC respondents, most interviewees highlighted the need to expand it beyond the insurance sector and **include other financial products and services** in its sphere of influence.

  In the workshop's breakout groups, participants representing national authorities and international organisations notably pointed out the importance of **overseeing how private and public investments are made**, and to develop guidance to

ensure win-wins between the adaptation/mitigation objectives of policymakers on the one hand, and risk minimisation objectives of investors on the other. The **new EU taxonomy was mentioned as playing a major role in incentivising investments**. This can be seen as echoing the demand for more standardisation in reporting and more prescriptive guidelines in the public sector.

Overall, private sector engagement was considered by interviewees and workshop participants from all stakeholder groups as an important component of the strategy to (1) ensure behavioural change and (2) to provide necessary funding (though without being the main source). Interviewees from local authorities pointed to a lack of direct return on investment (in terms of cash flows) of adaptation projects in general, including at the local level.

Potential new actions

Additional actions frequently suggested by workshop participants and interviewees alike include:

- An **emphasis on international action**. A large majority of interviewee and workshop participants noted the **importance for the EU of continuing support for other countries to enhance their adaptive capacity** and thereby prevent spillover effects of climate-related events elsewhere affecting Europe. This was highlighted by all stakeholder groups, but less so among business representatives. Reported spillover effects included climate-induced migration and disruption to supply chains. In turn, as part of the knowledge sharing efforts previously reported, interviewees highlighted an important opportunity for two-way learning on adaptation best practices with other countries that are already facing the impacts of climate change more severely.
- In addition, a new action encouraged by all stakeholders from interviews and workshops alike was the **communication to and involvement of EU citizens** in climate change adaptation. To this end, interviewees and webinar panellists mentioned the role of the media and use of digital tools to actively engage citizens and make knowledge and data accessible to all.

The following general considerations were also highlighted by the majority of interviewees and workshop participants when discussing potential new actions (actions are listed in order from the most to least suggested):

- Unlike OPC respondents, most interviewees and workshop participants from all stakeholder groups **advocated that sectors should not be prioritised.** Rather, they highlighted the importance of identifying actions horizontally across all sectors, to maximise cross-sectoral benefits and to prevent potential maladaptation. Those interviewees who did prioritise specific sectors were mostly experts from the relevant sectors (e.g. water was prioritised by an interviewee representing a water organisation, forestry was prioritised by an interviewee representing a forestry organisation).

  Instead of prioritising sectors, interviewees and workshop participants from all stakeholder groups overwhelmingly recommended that actions should be **prioritised in relation to vulnerabilities,** acknowledging the differences across Europe. The use of an EU-wide vulnerability assessment was highlighted by several workshop participants representing national authorities and was supported in some interviews by international organisations, civil society and business representatives. However, some workshop participants and interviewees from EU institutions and other national authorities' representatives did not consider it a priority in comparison to other suggested actions and considered that it might duplicate current efforts by the European Environment Agency.

- Workshop participants and interviewees from civil society, national authorities and businesses alike encouraged **greater implementation of nature-based solutions and the communication of successful and best-practice examples**. Several references were made to the value of water and forest ecosystems to the EU economy, justifying the importance of specific actions in those sectors. The diversification of systems was mentioned less by interviewees and workshop participants than by OPC respondents, and the transport and energy sectors were mostly considered in light of synergies between adaptation and mitigation.
- Some interviewees and workshop participants, in particular from businesses and national authorities, encouraged the **promotion of actions that span the adaptation-mitigation nexus.** They suggested that actions should be prioritised where there is potential for substantial synergies between mitigation and adaptation.

  Workshop participants representing Member States highlighted **the importance of differentiating between adaptation to slow-onset and extreme-weather events**. For the latter, in particular, interviewees highlighted the importance of being proactive, preparing, and planning before adverse impacts arise.

Given the importance of feedback received from national authorities, key points on their opinion of potential new actions of the strategy are presented in the box below.

Box 21: Feedback from National Authorities

Open public consultation

In total, 60 public authorities completed the OPC for the new EU Adaptation Strategy, including 23 national authorities from 14 EU Member States[213]. These included Austria, Belgium, Czechia, Estonia, Finland, France, Greece, Ireland, Italy, Latvia, the Netherlands, Portugal, Romania and Slovakia. Furthermore, three non-EU national authorities (one from Andorra and two from the United Kingdom) provided responses.

When asked to rate potential new actions for the new EU Adaptation Strategy, the majority of national authorities have indicated that "**helping to identify health and/or social risks linked to climate change at an early stage by developing an observatory of social/health vulnerability" was very important (9)**. Other actions that were considered as fairly important by the majority of national authorities included: "**supporting resilience investments and natural disaster insurance penetration through EU and MS policies**" (11) and "**increase in private investment in adaptation via increased public-private investment opportunities or incentives**" (9). "Strengthening the climate risk and vulnerability assessment at EU level, including on the EU outermost regions" was considered not important at all by 7 out of 23 national authorities, with the majority considering it only slightly important. "Providing **tailored adaptation guidance and peer-to-peer knowledge exchange** to public authorities and non- state actors" was also deemed not important (5) or only slightly important (8) by half of the national public authorities respondents, although it was the action most identified as "very important" by the wider public authorities stakeholders' group. Other actions were considered as important or slightly important.

National authorities who provided as an open-text response "further information that

[213] Multiple responses were received from: Austria, Greece, Ireland and Portugal.

[they believed] would be useful for preparing the EU's new Adaptation Strategy" have highlighted the **importance of knowledge exchange and further guidance on adaptation.** They also mentioned the following other areas needing action: better integrating and supporting sub-national authorities, including in rural areas; ensuring mainstreaming adaptation in sectoral policies; accounting for climate impacts outside the EU and collaborating internationally; and integrating mitigation and adaptation objectives together.

Additional material submitted

In total, eight position papers were received from EU national authorities, including three via the OPC and five directly over email. These came from the following Member States Denmark, Finland, France, Germany, Italy, Poland, Portugal and Spain.

Health and social impacts were only discussed in four of these position papers. These reiterated their support for an observatory dedicated to social/health vulnerability, or generally highlighted the importance for the Strategy to be equipped to address the impacts of climate change on the most exposed and most vulnerable citizens. As in the wider OPC results, the need to **increase investment in adaptation** was highlighted in the majority of the position papers, though with no specific focus on private investment. Respondents suggested an increase in adaptation funding overall, including through a new financial instrument from EU funds, or in general by increasing EU funding for adaptation. Public-private partnership was only specifically mentioned in one position paper.

Climate risks and vulnerability assessments were not specifically emphasised in the position papers. On the other hand, **peer-to-peer knowledge exchange** were deemed important aspects of the new Strategy in seven of the nine position papers received. National authorities called for a reinforcement of knowledge exchange and better coordination of adaptation action at different levels including better knowledge exchange across Member States, but also with governments outside the EU and between public authorities and practitioners. They suggested that the EU adopt a coordination role in these exchanges, by facilitating dialogue but also harmonising monitoring and evaluation criteria and data collection, and ensuring the convergence of national and regional strategies, climate plans, legal and technical regulations and legislation between neighbouring states to account for the vulnerability of cross-border territories and spill over effects.

Other areas for action suggested in national authorities' position papers **included nature-based solutions, international cooperation, and mainstreaming adaptation objectives in EU policies and funding.**

Stakeholder events

At the second stakeholder workshop, representatives from different Member States across the Working Group 6 were consulted again on potential actions for the new EU Adaptation Strategy. Participating Member States included Austria, Belgium, Czechia, Denmark, Finland, France, Germany, Greece, Ireland, Latvia, Portugal, Italy, Malta; the Netherlands, Slovenia, Spain and Sweden.

Out of the four breakout groups, two groups supported a new action addressing the health and social aspects of adaptation and three groups supported further action in knowledge sharing. Investment and financing were not reported as needing a new action or further enhancement by any group. In contrast, supporting Member States through **improved mechanisms for monitoring and evaluation** of adaptation action

was highlighted as a key new strand of action in all groups. Three groups also highlighted the need for better and harmonised data, and two groups explicitly welcomed a new action in international cooperation. Potential new actions were also welcome to (1) engage the wider public at an EU level, (2) increase the use of ecosystem- based solutions, in particular for green infrastructure and (3) further involve corporate businesses and the financial sector.

Impacts of the new EU Adaptation Strategy

Results from the OPC

Stakeholders mostly considered it very important for *the new EU Adaptation Strategy* to achieve the following impacts:

- *Healthier ecosystems with improved resilience to climate impacts* (73.3%),
- *Preventing climate risks* (69.9%),
- *Enhancing the resilience of the agri-food system to climate change* (66.8%) and
- *Enabling climate-informed decisions by citizens* (60.9%).

The latter was one of the most common topics addressed in the final open text replies, with a majority of respondents reiterating the importance of communication, citizen involvement and behavioural change. In response to the question on 'In your opinion, how important is it for local authorities to promote the engagement in adaptation action of citizens and stakeholders in the following ways?' the majority of respondents indicated that *informing about local climate risks and impacts* (74%) and *ensuring resources are available for the development and delivery of adaptation projects* (70%)[214] were very important.

Consistent with previous answers, more mixed responses were received for the *closing of climate protection gap (e.g. increasing insurance coverage)*, *climate and risk proofing of infrastructure and investments* (45.8%), *incorporating climate risk management into fiscal frameworks* (44.1%), *averting, minimising and addressing population displacement* (43.6%) and *increasing financial and economic resilience* (35.8%).

Similarities and differences with feedback from other consultation activities

Impacts of the new EU Adaptation Strategy were only specifically discussed during interviews. Interviewees were asked to identify whether the new EU Adaptation Strategy should prioritise economic and/or social and/or environmental impacts.

All interviewees from all stakeholder groups emphasised the importance of **considering all impacts as interconnected**, recognising that environmental impacts have economic and social repercussions, economic impacts have environmental and social repercussions, etc. As a result, it was not suggested that any specific impacts should be prioritised.

However, interviewees agreed with OPC respondents in highlighting the importance of achieving **healthier ecosystems** with improved resilience to climate impacts.

Economic impacts were less discussed compared to social and environmental impacts, apart from representatives of businesses. This may be due to most respondents' understanding that economic activity itself relies on the services that ecosystems provide. A large number of

[214] See Figure 3-33 in Appendix 1.A accompanying the consultation synopsis presenting the analysis of the OPC.

workshop participants and interviewees from all stakeholder groups (mostly civil society but also including businesses and national authorities) emphasised the importance of ecosystem-based adaptation and nature-based solutions.

Health and other social impacts were considered very important by interviewees, despite not being emphasised by the majority of OPC respondents. **Differences in social impacts and the "leaving no-one behind"** principle were highlighted as underlying principles to be considered in implementing each of the strategy's actions. Some interviewees argued that the current focus on social adaptation is insufficient, particularly for women and workers, in particular among civil society representatives.

According to interviewees, focusing on social impacts is important due to:

- **Differing vulnerabilities** across members of society (gender and occupation were highlighted), requiring prioritisation of actions.
- The risk of **negative spillover effects** of some actions potentially leading to maladaptation in some social groups.

6. Identified campaigns for consultations

The OPC open text responses were analysed to see if any of them had been co-ordinated by different respondents. Co-ordinated in this case refers to open text responses from different respondents that are identical or almost identical. To see how similar two sentences are, a Cosine Similarity calculation has been carried out[215]. The higher the cosine similarity, the more similar two responses are to one another, with a cosine similarity of 1.0 indicating identical text submissions. A cosine similarity of 0.5 or above indicates similarity between texts and hence the possibility of coordination.

The results of this analysis are summarised in Table 14. Each row in the table shows a set of similar co-ordinated responses and the stakeholder type of each response. For example, the first row shows that there were two responses, both submitted by trade union stakeholders, that were most likely co-ordinated, with a very high level of similarity between responses. Very high similarity has a cosine similarity of 0.9 and above.

The table indicates that there were only pairs and a triplet (see the second row of the table which shows that there were two responses from business associations and one from a company/business organisation, that were most likely co-ordinated) of organised responses, and there were no large campaigns of similar answers. The most common stakeholder type involved in these co-ordinated responses was business associations.

The triplet consisting of the same response highlighted that railways have adaptation plans in place. The co-ordinated response states that due to interlinkages mainly with the energy sector, a holistic approach is needed to guarantee resilience of the rail infrastructure.

[215] The calculation involves converting sentences to vectors and the similarity calculation measures the cosine of angle between two vectors.

Table 22: Results of cosine similarity analysis detecting co-ordinated responses

Level of similarity between the responses [216]	Stakeholder type						
	Trade union	NGO	Business association	Company/ business organisation	Public authority	Academic research institution	Other
Very high	2						
Very high			2	1			
Very high			2				
Very high		1	1				
Very high		1	1				
High		1	1				
High					2		
High			2				
High			1	1			
High	1						1
High					1	1	

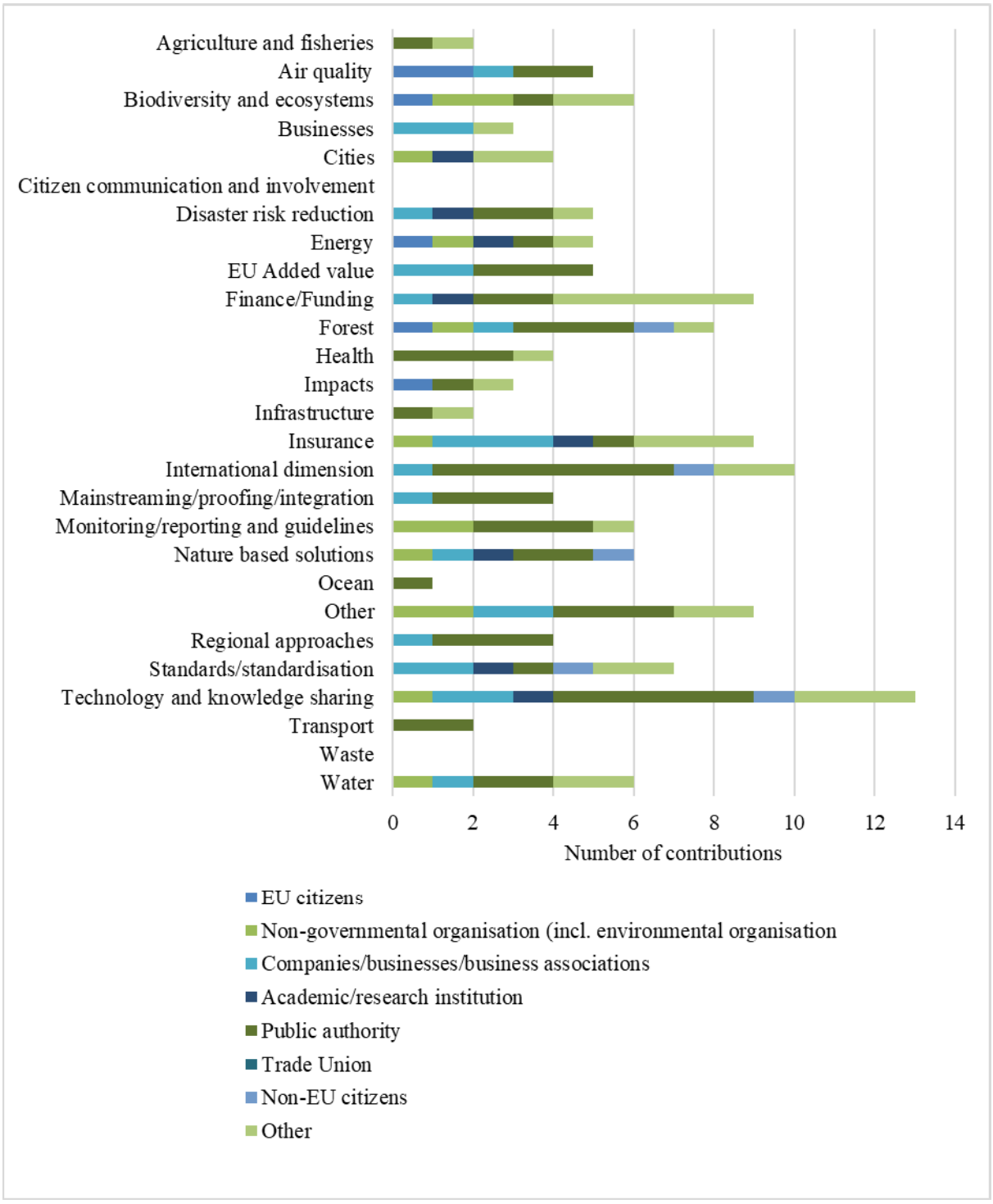
7. Ad-hoc contributions

Ad-hoc contributions (i.e. position papers and other types of documents submitted) were provided over email and referred to by stakeholders during the targeted stakeholders' interviews. These contributions have been analysed in the same way as contributions submitted via the OPC.

Overall, 26 contributions were received over emails from various stakeholders. Figure 9 shows the topics covered in those contributions by stakeholder type.

[216] Very high has a cosine similarity of 0.9 and above. High has a cosine similarity of 0.5 to 0.9

Figure 9: Overview of ad-hoc contributions' content provided over email by stakeholder type (a contribution can tackle one or more than one topic)



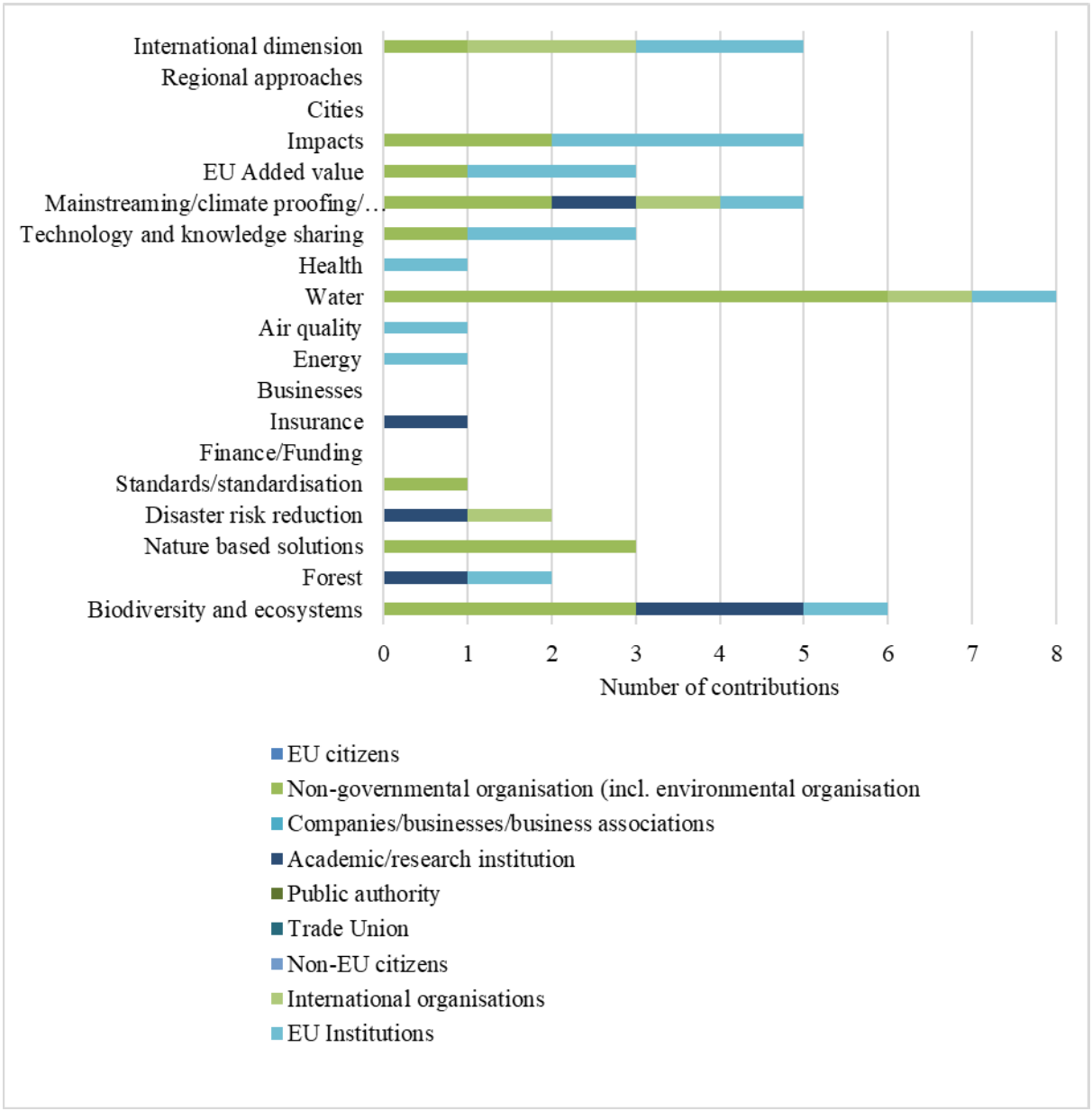
Source: Own analysis

Under the "Other" category, contributions from stakeholders covered the following topics to be addressed in the new Strategy: cross-border cooperation between Member States; strengthening local structures, processes, and institutions, working with civil society actors and existing networks; reinforcing the link with mitigation; providing data on monetary value for green infrastructure; reinforcing multi-level governance and prioritising initiatives with co-

benefits; accounting for differing social vulnerabilities, including gender- specific vulnerabilities.

Furthermore, seven interviewees provided additional contributions over email following their interviews. Overall, 22 additional documents were received. Figure 10 provides an overview of these documents' content, by stakeholder type.

Figure 10: Overview of ad-hoc contributions' content provided by interviewees by stakeholder type (a contribution can tackle one or more than one topic)



Source: Own analysis

Under the "Other" category, contributions from stakeholders discussed the integration of gender issues into policymaking, including how and why it should be mainstreamed in the new EU Adaptation Strategy. These papers highlighted gender imbalances in the agriculture and fisheries sectors, among others, and in climate policymaking in general.

8. How information from consultation is used in the impact assessment

The evidence-base collected through the consultation activities was recorded by the consultation team in the form of interview notes, webinar and workshop notes; summaries of position papers' and additional material received through the OPC or other channels; and graphs to visualise results from the OPC.

This information from the consultation formed a major part of the evidence considered in the impact assessment. The evidence was compared with evidence from other strands of the consultation and also with results of the literature review to identify the overall level of agreement or divergence of the evidence.

This was done (1) upstream, by providing support to the impact assessment team through weekly updates on the findings of the consultation activities, and (2) downstream, by crosschecking each policy option suggested against the evidence provided by consultation activities.

The full list of appendices accompanying this consultation synopsis include:

- Appendix 0.A: Summaries of ad-hoc contributions Appendix 1.A: Open public consultation
- Appendix 1.B: Open public consultation questionnaire Appendix 1.C: Open public consultation - Open text responses
- Appendix 1.D: Open public consultation - Summaries of submitted position papers and other documents
- Appendix 1. E: Open public consultation - 'Other' responses Appendix 2.A: Stakeholder interviews – Scripts and respondents Appendix 2.B: Stakeholder interviews – Preliminary interview script Appendix 2.C: Stakeholder interviews – Main interview script
- Appendix 2.D: Stakeholder interviews – European Commission invitation to contribute Appendix 3.A: Stakeholder events
- Appendix 3.B: Stakeholder events - Presentation of the webinar on 2 July 2020 Appendix 3.C: Stakeholder events - Presentation of the workshop on 3 July 2020 Appendix 3.D: Stakeholder events - Concept note of workshop on 3 July 2020 Appendix 3.E: Stakeholder events - Presentation of the workshop on 7 July 2020
- Appendix 3.F: Stakeholder events - Concept note developed for the workshop on 7 July 2020

Annex 3: Who is affected and how?

Table 23: Overview of Benefits (total for all provisions) – Preferred Option

I. Overview of Benefits (total for all provisions) – Preferred Option		
Description	***Amount***	***Comments***
Direct benefits		
A1 – Effective utilization of knowledge through systematic data collection and sharing, between key public and private partners.	Common benefits for public and private entities: Data harmonization; effective alignment between public and private responsibilities and effort sharing; improved adaptation planning; better informed decision making; better understanding between public and private losses. Reduced costs to be expected as robust data can drive CBA	Assumption: Climate data and knowledge is perceived as common good with great societal relevance. Data is of sufficient granularity
A2 – Proven performance from Climate-ADAPT as the 'first-stop shop' for adaptation information in Europe.	A single platform would reduce time to action, reducing costs. A first stop platform can guide to others without trying to stay up-to-date on everything at all time.	Distinction to be made between data provisioning, gathering of information and knowledge sharing. Different platforms for data, like Copernicus, EUROSTAT already provide some climate-related data. These services should be expanded per platform and linked to Climate-ADAPT
A3 - Robust evaluation, monitoring, reporting and implementation of adaptation strategies	Insight into Europe's vulnerability at the efficient level of granularity. Uniform and harmonized indicators can track impacts across Europe, and promote better exchange between Member States.	
A4 - Mainstreaming nature-based adaptation, including coastal protection and green and blue infrastructure.	Socio-economic and environmental benefits are more easily associated with ecosystems services. Therefore making more robust business cases warranting contribution and progress for sustainable development goals	
A5 - Stepping-up efforts to build resilience in cities and empower local action.	Reduced public expenditures on losses as result of climate impacts as city action plans put into action.	
A6 - Further mainstreaming and integrating adaptation in EU legislation and instruments	Greater spending on climate resilience in sectors affected by policy.	
A7 - Climate Proofing of Infrastructure and Disaster Risk Management.	Standardized guidelines and procedures to design, develop and integrate climate proofing solutions to ensure robust and resilient infrastructure across Europe	
A8 - Closing the Climate Protection gap - microeconomic aspects of adaptation to climate change.	Having systematic approach to assess, reduce, and optimally transfer climate-related disaster risk in economic activities	
A9 - Supporting partner countries and regions in their efforts on climate change and disaster preparedness	Implementation of NDCs and to building capacity at national and sub-national level in line with national priorities and vulnerabilities	
A10 - Scaling up international adaptation finance and disaster risk financing, and unlocking	Having more funds available from both the public and private sector, fostering the transition to be become climate	

private finance	resilient	
A11 - Strengthening EU engagement globally and learning from adaptation forerunners.	Access to granular and meaningful data information to ensure better informed decision making	
A12 - Horizon Europe Mission on adaptation to Climate Change effectively deploying adaptation Solutions	Better informed decision making by means of climate risk management and community-based emergency plans	
A13 - Closing the Climate Protection Gap - macroeconomic aspects of adaptation	Better-informed decision making for fiscal and financial stability: on disaster risk assessment and management, risk pooling and cross-sectoral losses.	
A14 - Ensuring the availability of Fresh water		
Indirect benefits		
A1 – Effective utilization of knowledge through systematic data collection and sharing, between key public and private partners.	Overall benefits to society from wide range of stakeholders benefitting from better data availability and informed decision making by public authorities and firms.	
A2 – Proven performance from Climate-ADAPT as the 'first-stop shop' for adaptation information in Europe.	N/A	Direct benefit to users is most relevant.
A3 - Robust evaluation, monitoring, reporting and implementation of adaptation strategies.	Benefits to vulnerable stakeholders as monitoring and reporting brings public action into focus, and stimulates further action.	
A4 - Mainstreaming nature-based adaptation, including coastal protection and green and blue infrastructure.	Benefits to biodiversity and climate change mitigation from projects in addition to main climate resilience benefits.	
A5 - Stepping-up efforts to build resilience in cities and empower local action.	Benefits to vulnerable stakeholders in cities as strengthened CoM and action by cities can lead to co-benefits in air quality, transport and public spaces.	
A6 - Further mainstreaming and integrating adaptation in EU legislation and instruments	Benefits to recipients of funding, as their vulnerabilities will be better addressed.	
A7 - Climate Proofing of Infrastructure and beyond.	Long term benefits to public budgets in Member States as reduced costs for repairs from climate damages to infrastructure.	
A8 - Closing the Climate Protection gap - microeconomic aspects of adaptation to climate change.		
A9 - Supporting partner countries and regions in their efforts on climate change and disaster preparedness	Improved EU standing on adaptation, and working with partners, may support building of diplomatic coalitions in other climate (mitigation) areas, or policy and economic areas more broadly.	

A10 - Scaling up international adaptation finance and disaster risk financing, and unlocking private finance		
A11 - Strengthening EU engagement globally and learning from adaptation forerunners.		
A12 - Horizon Europe Mission on adaptation to Climate Change effectively deploying adaptation Solutions	Pioneering innovations can create opportunities for EU firms to commercialise success stories.	
A13 - Closing the Climate Protection Gap - macroeconomic aspects of adaptation		
A14 - Ensuring the availability of Fresh water	Better water pricing and practices improves resource efficiency and water availability and quality for ecosystems and recreation.	

(1) Estimates are relative to the baseline for the preferred option as a whole (i.e. the impact of individual actions/obligations of the preferred option are aggregated together); (2) Please indicate which stakeholder group is the main recipient of the benefit in the comment section;(3) For reductions in regulatory costs, please describe details as to how the saving arises (e.g. reductions in compliance costs, administrative costs, regulatory charges, enforcement costs, etc.; see section 6 of the attached guidance).

Table 24: Overview of costs – Preferred option

II. Overview of costs – Preferred option							
		Citizens/Consumers		Businesses		Administrations	
		One-off	Recurrent	One-off	Recurrent	One-off	Recurrent
A1 – Effective utilization of knowledge through systematic data collection and sharing, between key public and private partners.	Direct costs					Measures to develop Roadmap, establish framework (EC)	Data sharing and provision
	Indirect costs				Provision of additional data		Through Horizon Europe
A2 – Proven performance from Climate-ADAPT as the 'first-stop shop' for adaptation information in Europe.	Direct costs						Establish and maintain Health Observatory (EC)
	Indirect costs						
A3 - Robust evaluation, monitoring, reporting and implementation of adaptation strategies.	Direct costs		Potential costs related to implementation (behaviour change, investments in individual resilience)	Potential costs related to aligning business activities with the strategies	Potential costs related to implementation	Establish framework (EC)	

II. Overview of costs – Preferred option

		Citizens/Consumers		Businesses		Administrations	
		One-off	Recurrent	One-off	Recurrent	One-off	Recurrent
	Indirect costs				Potential loss of revenue for sectors still building grey infrastructure		MRE under Climate Law (MS & EC)
A4 - Mainstreaming nature-based adaptation, including coastal protection and green and blue infrastructure	Direct costs					Tool development (EC)	
	Indirect costs				Possible via linking of insurance products to NbS		
A5 - Stepping-up efforts to build resilience in cities and empower local action.	Direct costs						Policy support facility (EC)
	Indirect costs						Implementation of adaptation plans (MS, cities)
A6 - Further mainstreaming and integrating adaptation in EU legislation and instruments	Direct costs						
	Indirect costs				Legislation to protect workers from high temperatures Potential higher costs associated with alignment with new adaptation requirements		Revision of existing legislation and instruments which do not incorporate adaptation considerations (EC)
A7 - Climate Proofing of Infrastructure and beyond.	Direct costs					Enhance and apply climate proofing methodology (EC) Study on Climate risk management (EC)	
	Indirect costs				Applying climate proofing guidelines		
A8 - Closing the Climate Protection gap - microeconomic aspects of adaptation	Direct costs					Common methods for risk management	Mainstreaming in BRG (EC) Allies for climate

II. Overview of costs – Preferred option

		Citizens/Consumers		Businesses		Administrations	
		One-off	Recurrent	One-off	Recurrent	One-off	Recurrent
to climate change.						(EC)	resilience (EC)
	Indirect costs				Adaptation integrated into SEAI		MS reporting on disaster aid (MS)
A9 - Supporting partner countries and regions in their efforts on climate change and disaster preparedness	Direct costs						Various measures (EC)
	Indirect costs						
A10 - Scaling up international adaptation finance and disaster risk financing, and unlocking private finance	Direct costs					Studies on just resilience (EC)	Climate proofing of EU external investments (EC)
	Indirect costs						Balance in mitigation and adaptation spending (all countries)
A11 - Strengthening EU engagement globally and learning from adaptation forerunners.	Direct costs						Discussions, exchanges, alliances (EC and partners)
	Indirect costs						
A12 - Horizon Europe Mission on adaptation to Climate Change effectively deploying adaptation Solutions	Direct costs						Horizon Europe and other activities funding (EC)
	Indirect costs						
A13 - Closing the Climate Protection Gap - macroeconomic aspects of adaptation	Direct costs					EC activities to provide tools, models, tests (EC)	EC engagement activities (EC)
	Indirect costs				Potential need to engage with and use EC tools.		Involvement in EC driven processes (MS)
A14 - Ensuring the availability of Fresh water	Direct costs					Regulatory changes and studies to support them (EC)	
	Indirect costs	Potentially higher product costs	Potentially higher water costs	Redesign of products, processes. New	Potentially higher water costs	Water Safety Plans development	

II. Overview of costs – Preferred option							
		Citizens/Consumers		Businesses		Administrations	
		One-off	Recurrent	One-off	Recurrent	One-off	Recurrent
				standards/labels		(MS)	

(1) Estimates to be provided with respect to the baseline; (2) costs are provided for each identifiable action/obligation of the preferred option otherwise for all retained options when no preferred option is specified; (3) If relevant and available, please present information on costs according to the standard typology of costs (compliance costs, regulatory charges, hassle costs, administrative costs, enforcement costs, indirect costs; see section 6 of the attached guidance).

Annex 4: Analytical methods

Aside from desk review, thematics reports and consultative approaches the Impact Assessment also utilised economic modelling to estimate the impact of a handful of the measures taken for mini-assessment (see Annex 7). The key characteristics of this are described below.

Economic modelling

The GINFORS-E model was used to provide macro-econometric estimations of the impact of measures under the Adaptation Strategy. A more complete description of baseline assumptions and how measures proposed under the Strategy were modelled is provided below, along with the summary of the main model features.

Three climate change scenarios and the respective adaptation scenarios are compared against a references scenario, which is mainly calibrated to the IEA's WEO 2019 stated policies scenario (IEA 2019). For EU countries, GDP and population development is calibrated to meet the EU (2018) aging report results (Lutz et al. 2020). GINFORS-E[217] is a global economy-energy model including national models for all EU countries and major trade partners linked by bilateral trade at industry level (solved annually until 2050). It is a macro econometric model similar to E3ME (Barker et al. 2011; Lehr, Lutz 2020).

Using quantifications of damages from past events as input, GINFORS_E estimates impacts at industry level, including macroeconomic effects (GDP, employment, production, consumer prices) and impacts on income and consumption structure for each EU Member State. Other examples include the detailed economic assessment of the German adaptation policies, applying a single country model with the same philosophy as GINFORS-E (Lehr et al. 2020).

Results are reported as relative differences in 2030, 2040 and 2050 against the reference scenario. Country specific economic structures, damages due to climate change and policy measures to adapt to climate change translate into different impacts on country level. The results are available on country level, but are shown for four regions and the current EU-27.

The economic losses are calculated for 2050, the model interpolates from today. The sources are used as follows:

- EEA Report No 1/2017 Climate change, impacts and vulnerability in Europe 2016
- An indicator-based report is used to determine the losses in agriculture for the RCP4.5 scenario. The upper and lower scenario is calculated based on own assumptions.
- Energy costs are simulated using the changes in electricity production costs from PESETA IV. The results are assumed for 2050 with model interpolation from today.

The assumptions used for the reference scenario are taken from a variety of sources and are combined in a methodologically rough way for feasibility of impact assessment study. One example, while the results from PESETA come from a comparative static analysis, the GINFORS-E model is a dynamic environment where the economies of the member states develop over time. The increasing (or in some cases possibly decreasing) vulnerability of a

[217] https://www.gws-os.com/de/index.php/energy-and-climate/models/model-details/ginfors-e.html

member state's economy by 2050 is not accounted for. This would be a relevant and interesting, but far more comprehensive study than can be provided here. The different types of models used in the analyses make comparison difficult, but the most comprehensive work on climate damages in Europe stems from the PESETA project cycle. Therefore, the results from the comparative static analysis in PESETA IV haven been interpreted against the macroeconometric models background and tried to reach similar results.

Five types of damages due to climate change have been implemented in the baseline. (1) For agriculture, climate change effects result in higher prices for the products, if the sector suffers from climate change. They translate into output losses via the input-output tables, mainly for agriculture, but also for other industries, such as food, that use agricultural products. (2) Higher cooling and lower heating demand are implemented in the physical energy balances of the models, i.e. as changes in consumption of electricity (for cooling) and different energy carriers (for heating). Changes in energy consumption (and transformation) in physical terms are translated into the monetary demand changes in the input-output tables and respective percentage changes. Consumers will adjust their consumption structure. (3) Changes in tourism turnover are interpreted as changes in final demand for the sector accommodation and food services. Intermediate inputs and other final demand categories will also change according to the economic structures in the IO tables. It is assumed that lower demand will not be compensated by additional demand in other categories to get a more pronounced negative economic impact of lower tourism activities and thus to be able to isolate and track effects. (4) Coastal damages and damages of the transport system are related to less transport. As in (3) these damages have been modelled as lower demand for (maritime) transport, which also has negative impacts on output of the transport industry and of other connected industries. (5) Health impacts of climate change, i.e. of heat waves and an increase in average temperature are considered as lower labour productivity. This is introduced to the model as an increase in user costs, which determine production prices, for all industries. This means that negative health impacts will increase the price level of the respective economy, which has negative effects on international competitiveness and reduces the purchasing power of consumers in the country. In contrast to (1) to (4) the effects spread widely across the economy. Changes in GDP in the countries reflect direct, indirect and induced effects of these assumptions for changes in prices and in demand. Employment is also a result of the model, mainly depending on production and relative prices (labour costs to production prices) in each industry. Wages in turn are a function of productivity development and price levels. As a consequence, percentage changes in employment as the number of employees are in general lower than percentage changes in production or GDP respectively.

Modelling reduced damages due to adaptation measures is straightforward. If adaptation reduces a damage by e.g. 10%, assumptions described above to model climate change have been reduced by 10% as well. Additional economic effects stem from explicit modelling of adaptation measures. Adaptation measures in retention areas, resilient cities and infrastructure (measures 4.1, 5.6, 7.2 respectively) have been modelled as additional investment of the construction industry. There is no crowding out assumed. Adaptation that improves the health situation (measure 2.1) is modelled as additional investment of the sector "human health and social work". Again, no potential crowding out is assumed. Adaptation measures to reduce the

impacts of draughts have been implemented as additional demand for machinery (measure 14.3). In all cases no crowding out has been assumed.

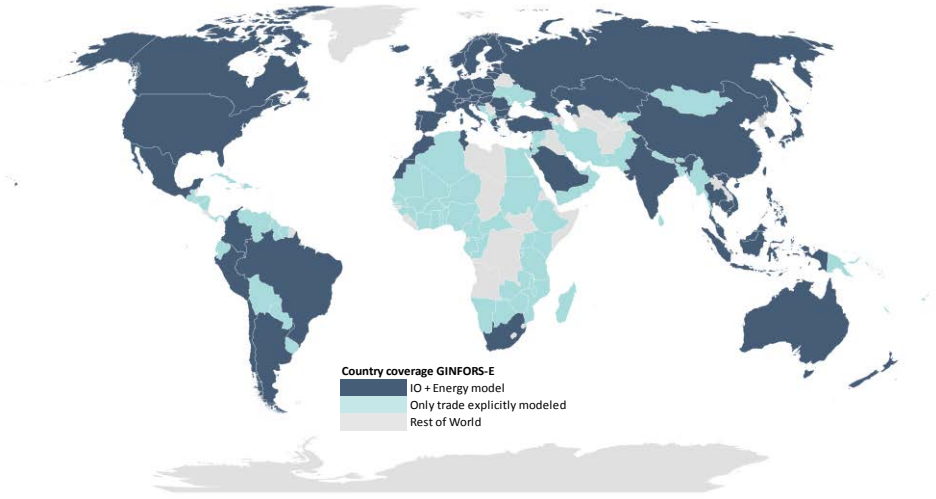
The specific assumptions per measure are discussed within the macroeconomic impact of the mini-assessments provided in Annex 7, specifically for the five measures (2.1, 4.1, 5.6, 7.2 and 14.3) for which economic modelling was possible.

The Impact Assessment study has been reviewed by an independent adaptation expert and sections of the report, including the mini-assessments, have received inputs from sector experts within and outside of the European Commission – these have increased the robustness of the findings.

GINFORS-E: Short model description

The GINFORS-E (global inter-industry forecasting system – energy) model is a bilateral world trade model mainly based on OECD data, which consistently and coherently models exports and imports of 25 goods groups for 64 countries and one 'rest of the world' region (**Error! Reference source not found.**). It incorporates a macro-model, consisting of exports and imports, other core components of final demand (private and public sector consumption and investment), markets for goods and the labour market, for each country. The models are also divided into 36 goods categories in accordance with the latest OECD (2019) internationally harmonised input-output (IO) tables (see Table 25: Industry classification of OECD Input-Output Tables (GINFORS-E) for sector detail).

Figure 11: Country coverage of GINFORS-E



For every country OECD, bilateral trade data on industry level is linked to the IO tables (**Error! Reference source not found.**). IO table detail is shown in **Error! Reference source not found.**13. In Lutz et al. (2010) the model is clearly described in detail, although some of the relations have changed (e.g. OECD has adjusted the sector classification several times). GINFORS-E flexibly models trade structures, labour markets, energy intensities and energy source structures, taking into account price dependencies and the situation in specific countries. The use of intermediate inputs, domestic and imported, labour demand and foreign

trade are modelled price dependent. The parameters used in the model equations are econometrically estimated (OLS) based on time-series data, if the time series are sufficiently long.

GINFORS-E incorporates a macro-model from TINFORGE (Mönnig, Wolter 2020), consisting of exports and imports, other core components of final demand (private and public sector consumption and investment), markets for goods and the labour market, for each country.

Production prices of 36 industries are driven by unit costs. If prices of electricity in the steel industry increase, producer prices will increase according to their electricity price share. Higher producer prices will influence global competitiveness of the respective industry and other downstream production (e.g. in the automotive industry).

Behavioural parameters of the model are estimated econometrically, and different specifications of the functions are tested against each other, which gives the model an empirical validation. An additional confirmation of the model structure as a whole is given by the convergence property of the solution, which has to be fulfilled on a yearly basis. The econometric estimations build on times series from OECD, UN, IMF and IEA from 1990/2005 to 2015/2017.

Figure 12: Country model of GINFORS-E

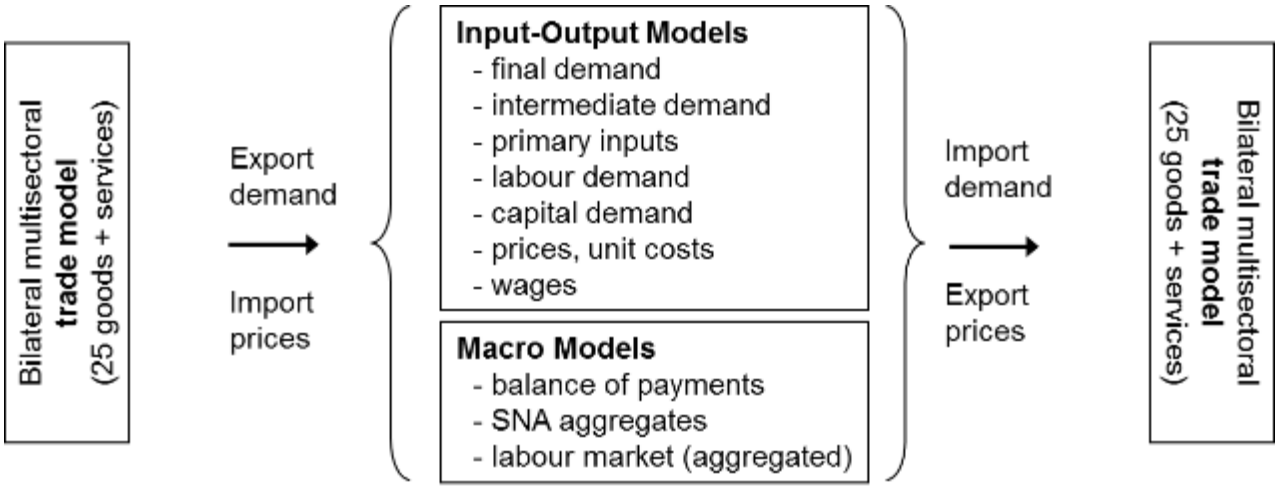
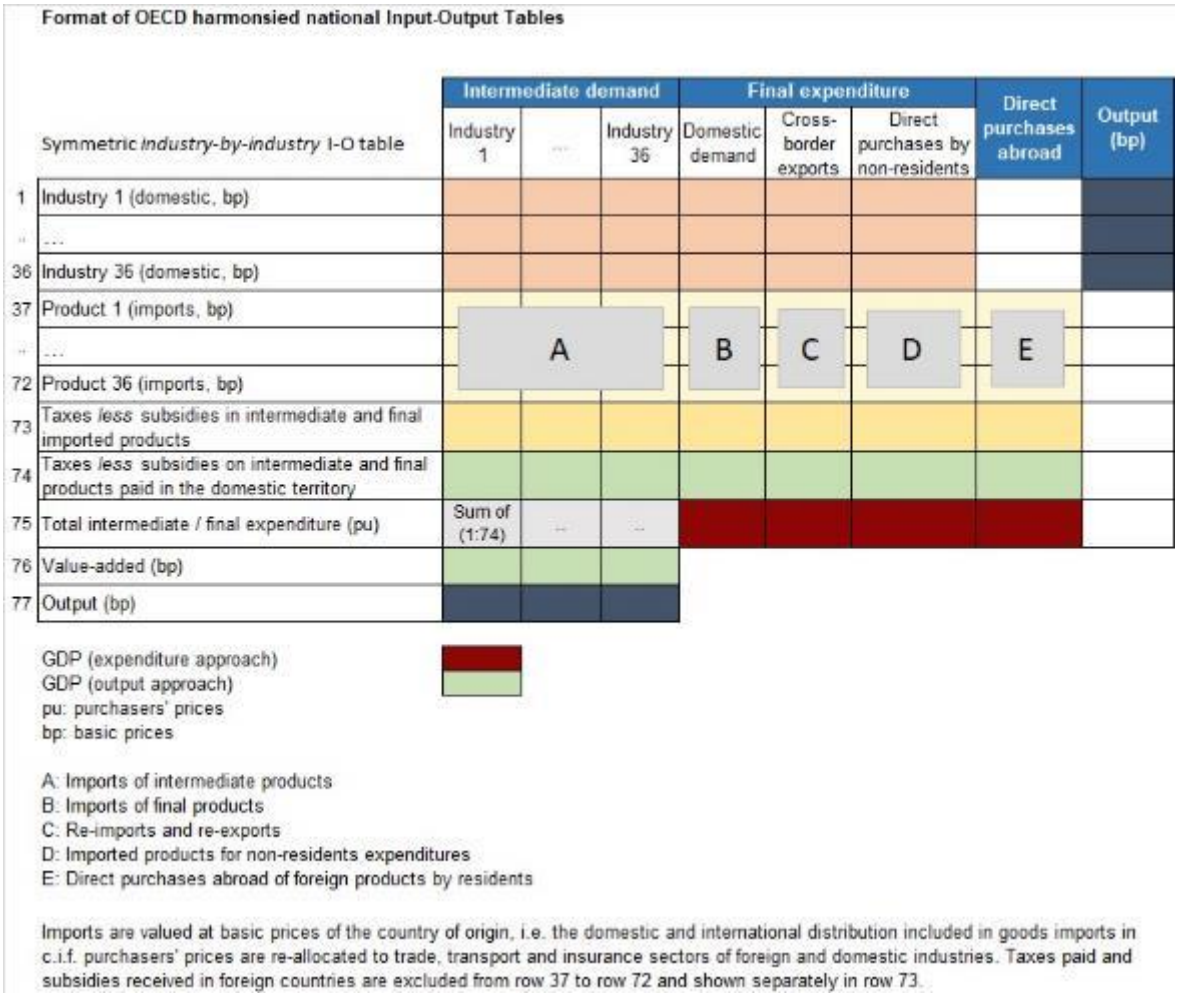


Figure 13: Structural detail of IO country model of GINFORS-E



Source: OECD 2019

Each national model is linked to an energy model, which determines energy conversion, energy generation and final demand for energy for 19 energy sources disaggregated by economic sector. The model takes into account technological trends and price dependencies.

For DG CLIMA the model has been used to project consumption-based emissions and evaluate specific technology scenarios taking global supply chains into account (Wiebe et al. 2016). For DG GROW (Asselin-Miller et al. 2017) the model has been used to explore macroeconomic impacts of different scenarios for powertrains and the competitiveness of the European automobile industry. It also shows how electric cars can be captured in an input-output framework.

Table 25: Industry classification of OECD Input-Output Tables (GINFORS-E)

Industries 1-24	Industries 25-48
1 Agriculture, hunting, forestry and fishing	19 Other transport equipment
2 Mining and quarrying	20 Manufacturing nec.; recycling
3 Food products, beverages and tobacco	21 Electricity, gas and water supply
4 Textiles, textile products, leather and footwear	22 Construction
5 Food products, beverages and tobacco	23 Wholesale & retail trade; repairs
6 Textiles, textile products, leather and footwear	24 Hotels & restaurants

7 Wood and products of wood and cork	25 Transport & storage
8 Pulp, paper, paper products, printing and publishing	26 Post & telecommunications
9 Coke, refined petroleum products and nuclear fuel	27 Financial intermediation
10 Chemicals and chemical products	28 Real estate activities
11 Rubber & plastics products	29 Renting of machinery & equipment
12 Other non-metallic mineral products	30 Computer & related activities
13 Basic metals	31 Computer & related activities
14 Fabricated metal products	32 Research & development and other business activities
15 Machinery & equipment, nec	33 Public admin. & defence; compulsory social security
16 Computer, Electronic and optical equipment	34 Education
17 Electrical machinery & apparatus, nec	35 Health & social work
18 Motor vehicles, trailers & semi-trailers	36 Other community, social & personal services

Source: OECD 2019 https://www.oecd.org/sti/ind/IOT_Industries_Items.pdf

Ultimately, two basic types of macroeconomic models can be distinguished, which are used for the macroeconomic assessment of the energy transition and climate policies or climate change: general equilibrium models (CGE) and macro-econometric models (sometimes also known as macro-econometric input-output models). According to an EC study, the two types of models can be distinguished as follows (Pollitt et al. 2017): Computable General Equilibrium (CGE) models are based on neo-classical theory that households and businesses maximize their benefits and profits. The markets of different goods are cleared (are in an equilibrium), i.e. supply and demand balance and economic resources are fully utilized. Involuntary unemployment is not possible in the standard case. Higher demand for a good (for example, renewable energy required for the energy transition) leads to higher prices of primary factors (energy, capital, labour) and a reallocation of resources away from the optimal. Macro-econometric models are based on the post-Keynesian theory that emphasizes the demand side, with both market sides playing an important role, unlike simple input-output approaches. Behavioural parameters are determined by econometric estimation of time series data, so the empirical estimation of model parameters is of great importance. Markets are usually not cleared, as the economy is assumed not to be in equilibrium. Involuntary unemployment and idle capital are included. Imbalances between supply and demand are more likely to be offset by demand-driven rather than price effects. However, the study also emphasizes that the models used in policy advice break away from rigid theories to more adequately reflect reality.

Uncertainty and sensitivity analysis

Uncertainty has an important role in analysis of climate change and its future impacts as there is both (1) uncertainty in the modelling of impacts, with our understanding of these improving but not complete; and, (2) uncertainty in the mitigation efforts that will shape the future climate impacts we will face. Uncertainty in climate analysis is typically dealt with using climate scenarios, modelling different policy, emissions and temperature pathways. This work also utilises a scenario-based approach to sensitivity check the impacts. Quantitatively, as described above three scenarios are modelled based on the IPCC RCP scenarios 2.6, 4.5 and 8.5. These correspond to estimated temperature increases, although within a range due to the modelling uncertainty described above (1), which could be described as low-medium-high. The detailed quantitative results for economic welfare and employment in chapter 6 present

the impact at this level. The qualitative assessment of the results is unable to make such a precise distinction between scenarios and these are therefore assessed simply as Paris (low/medium) and High temperature scenario impacts. This provides a useful indication of the sensitivity of the assessment to climate uncertainties. The measures are held constant across the scenarios, but with the underlying rationale: that climate damages increase with temperature, and that measures also typically have a greater impact on avoiding or reducing these damages as the temperature increases.

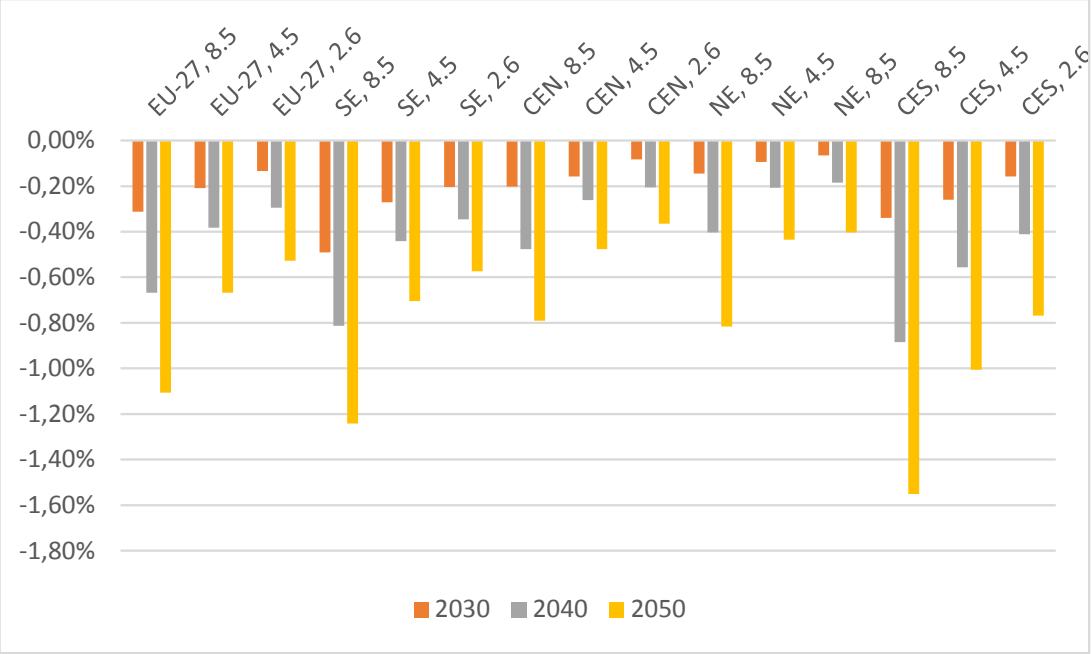
Detailed modelling results

Climate change scenarios

Climate change will reduce economic welfare in the coming decades depending on country specific damages. While Northern Europe can even partly profit regarding energy demand for heating of buildings from climate change, especially southern Europe will be hit by high temperatures, which will increase the possibility of droughts and energy demand (and costs) of cooling. Countries with high shares of agriculture and tourism will suffer more.

Figure 14 shows impacts of climate change on GDP in different EU regions. Southern Europe (SE) and Central Southern Europe (CES) will be hit most by climate change. Relative losses in Central Northern Europe (CEN), in Northern Europe (NE) and in Ireland are lower than in the South, but still significant. In scenarios with faster climate change (8.5) GDP losses will be significantly higher than in scenarios with lower temperature rise (2.6).Figure 12 shows impacts of climate change on GDP in different EU regions. Southern Europe (SE) and Central Southern Europe (CES) will be hit most by climate change. Relative losses are below EU average in Central Northern Europe (CEN), in Northern Europe (NE) and in Ireland. In scenarios with faster climate change (8.5) GDP losses will be significantly higher than in scenarios with lower temperature rise (2.6).

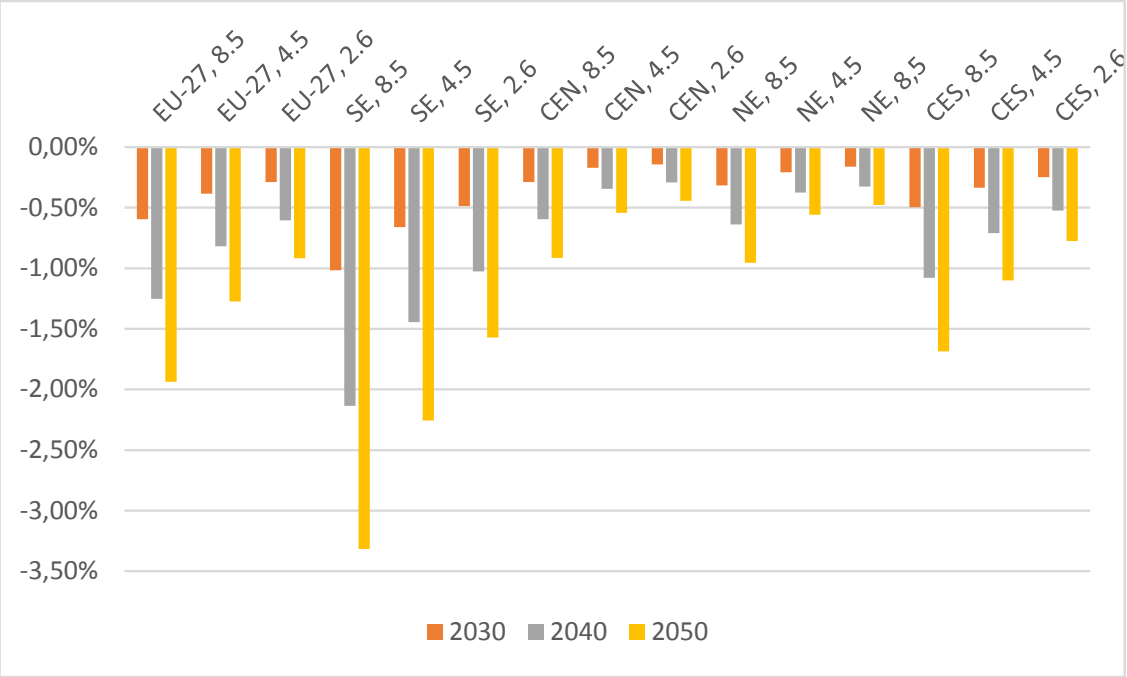
Figure 14: Economic welfare in climate change scenarios by macro region - relative difference from baseline [% of real GDP]



Own results

A similar pattern of changes can be observed for employment (Figure 15). However, the magnitude of effects will be much higher, especially in Southern Europe, where employment is reduced by more than 3% in the 8.5 scenario (Figure 13). Nevertheless, the magnitude of effects will be much higher, especially in Southern Europe, where employment is reduced by more than

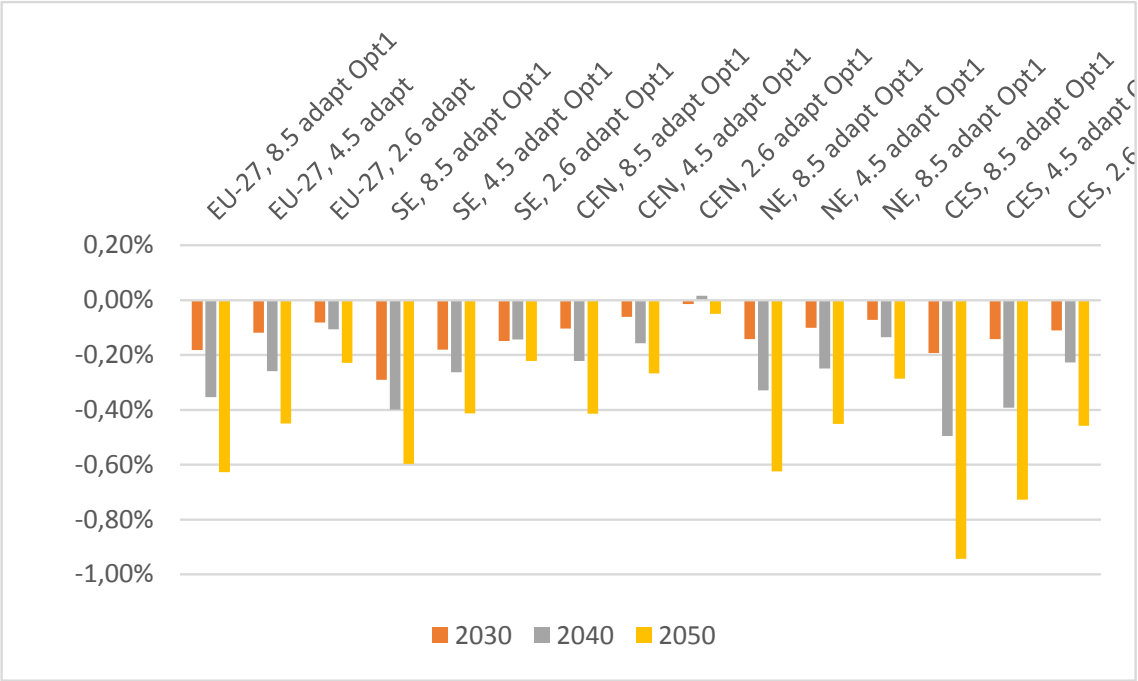
Figure 15: Employment in climate change scenarios - relative difference from baseline of employment by macro region



Adaptation scenarios – Option 1

Adaptation measures as described above (see also Annex 6 and 7) can reduce the negative economic impacts of climate change in terms of economic welfare. They could be more than halved for the EU-27 in the 8.5 scenario compared to the baseline (Option 0). High reductions can also be seen for Southern Europe and Central Southern Europe (Figure 16**Error! Reference source not found.**).

Figure 16: Adaptation scenario (Option 1)- relative difference from baseline of real GDP by macro region [as % of real GDP]



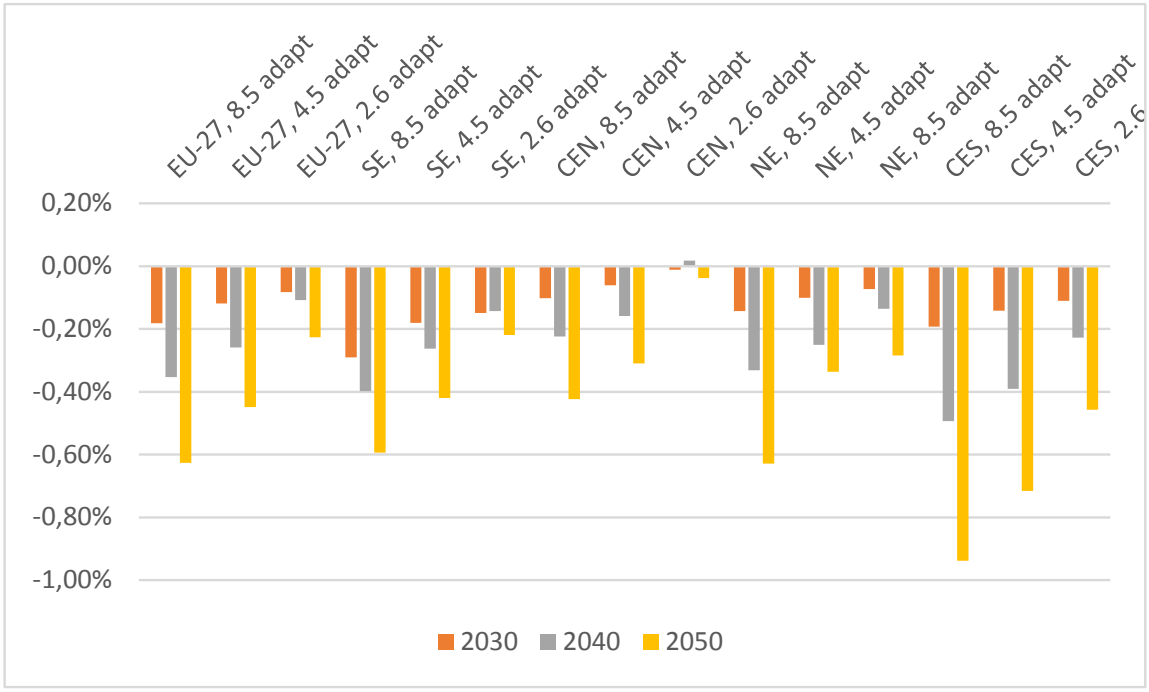
Own results

Adaptation scenarios – Option 1 and Option 2

The added effects of the Option 2 measures are almost identical to Option 1 (**Error! Reference source not found.**), as it was only possible to model measure 14.3 which improves water availability in agriculture in some (southern) EU countries slightly and "costs" are accounted for as a shift from water to machinery inputs. This only has small impacts in the additional economic activities triggered by construction, the health system, or other economic sectors. Note that investment in these purposes is treated as additional with no assumptions, for instance, regarding crowding out. This highlights one of the important limitations of this kind of analysis, as the economic parameters become more and more uncertain when looking more than a few years ahead.

Adaptation can lead to neither GDP nor employment to reach identical levels than in the absence of climate change effects, because it can lower damages from climate change, but never completely compensate for them. However, some of the adaptation measures considered above would be low- or no-regret strategies. Retention areas, for instance have other benefits, also without the major flooding event, which they have been developed to prevent. They can serve as parks or recreation areas during the times without flooding (for example see the research project MUST; https://www.must.nl/).

Figure 17: Adaptation scenario (Option 2) - relative difference of economic welfare compared to baseline by macro region [as % of real GDP]



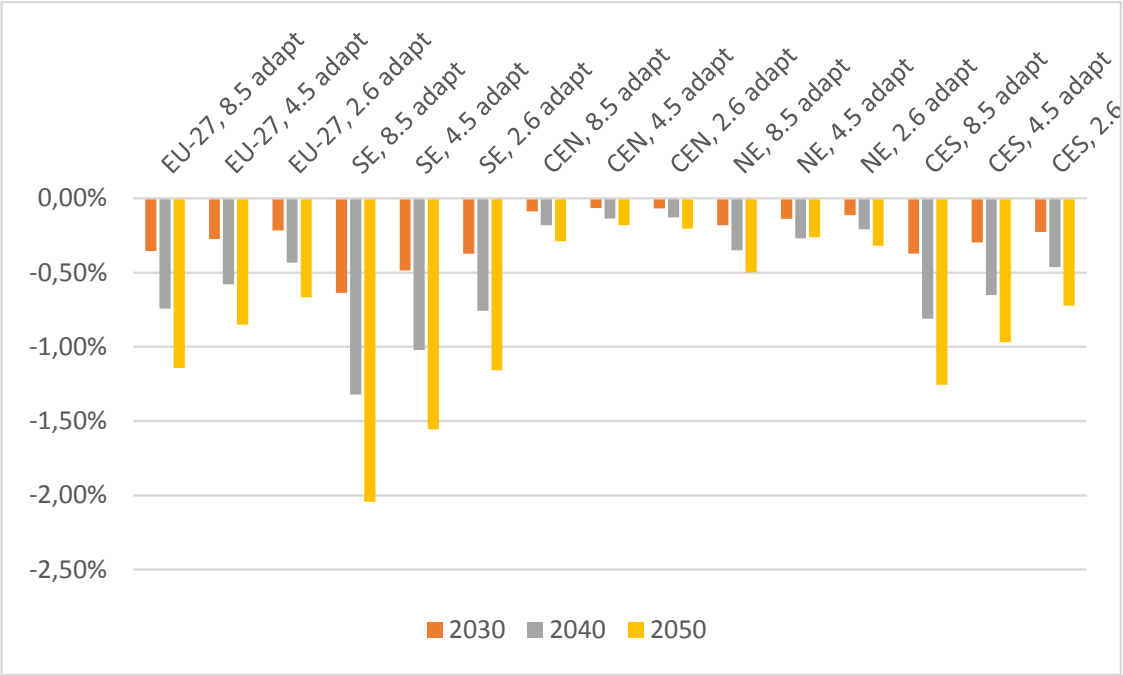
Own results

The reasons for positive macroeconomic effects from adaptation lie in the reduction of damages

The results of the simulation of the additional options are optimistic. The measures suggested are fairly soft and require full implementation to reach their impacts. However, for simulation purposes, we have assumed that they will be fully effective and implemented 1:1 in practice.

Employment losses will also be lower with adaptation measures (**Error! Reference source not found.**). The relation between economic welfare losses and employment losses reflects the different productivities and industrial structure of reduced losses and additional measures for each country. The figure shows that employment losses which totalled 1.27% in the baseline (for RCP 4.5) could be reduced to 0.85% by Option 2, the difference is the equivalent of around 800,000 jobs based on current EU employment of 191 million. Avoided job losses increase further in the high temperature (RCP 8.5) scenario.

Figure 18: Adaptation scenarios (Option 2) - relative difference of employment by macro region compared to baseline [as % of total employment]



Own results

Country and temperature scenario details for Option 2

The following figures, Figure 19, and 21, provide insight at the country level for the impact of Option 2, by comparing the with and without adaptation outcomes for economic welfare across the 3 temperature scenarios. These show that across every temperature scenario every country experiences reduced economic losses due to the adaptation actions modelled for Option 2. In a handful of countries, e.g. especially Austria, but also Germany, Estonia and Latvia in different scenarios, the measures even reverse the economic welfare losses into small economic welfare gains.

Figure 19: 1.5°C scenario (RCP 2.6) Relative differences in economic welfare compared to baseline by 2050 [as % of real annual GDP]

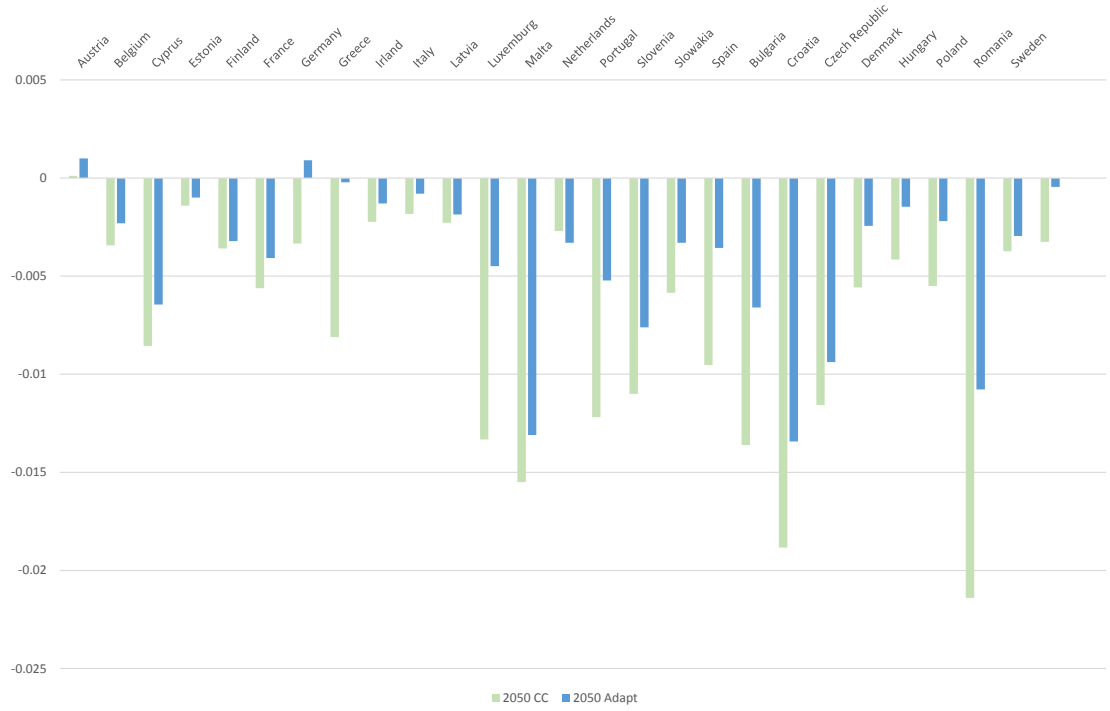


Figure 20: 2.0°C scenario (RCP 4.5) Relative differences in economic welfare by 2050 compared to baseline [as % of real annual GDP]

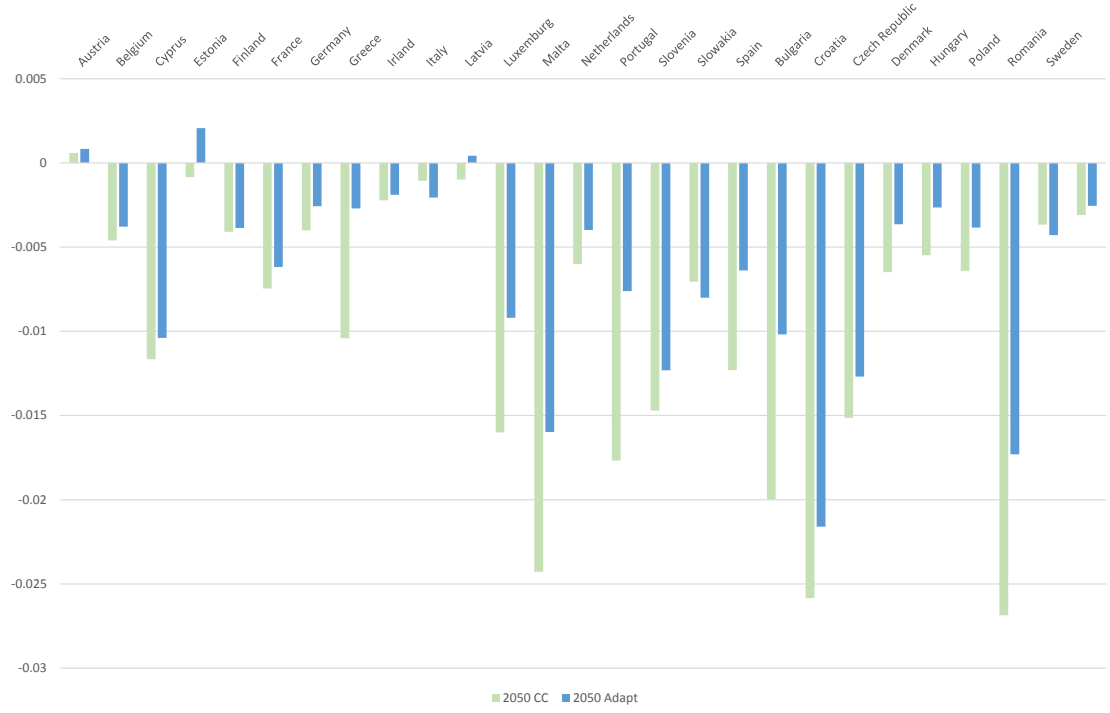
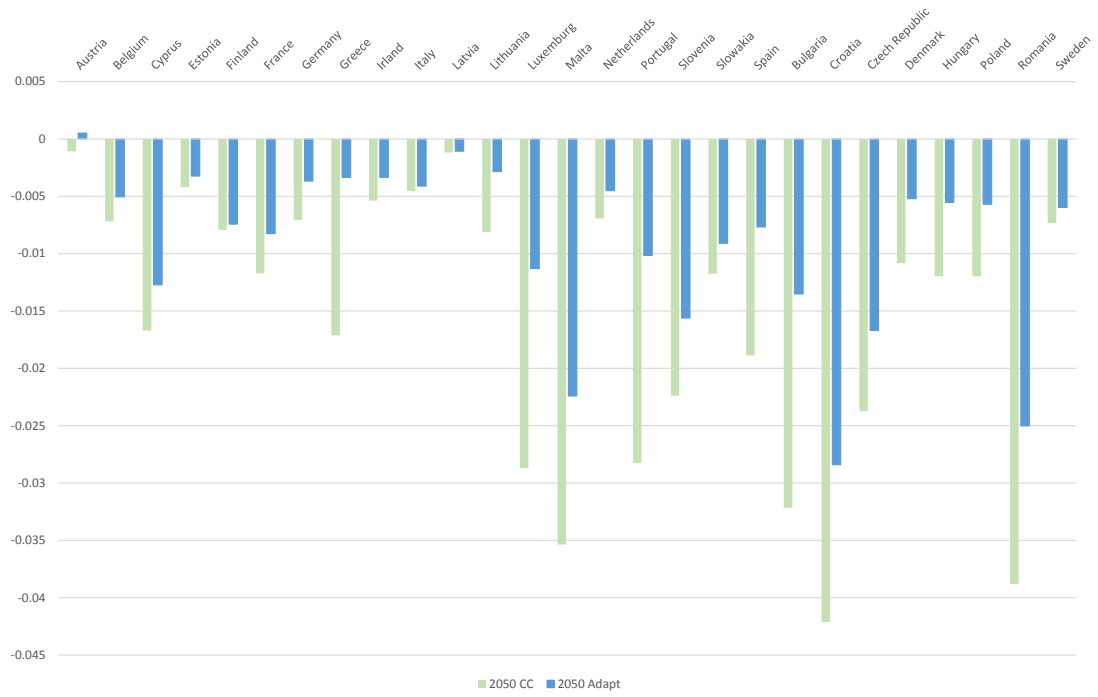


Figure 21: 4°C scenario (RCP 8.5) Relative differences in economic welfare by 2050 compared to baseline [as % of real GDP]



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Annex 5: Impact screening

Following Better Regulation Tool #19 we have undertaken an impact screening to identify the most significant impacts to be assessed as part of the IA. The impacts to be assessed flow from the problem definition and the objectives as presented in chapters 2 and 4 of the main IA.

The Adaptation Strategy has, through the various actions and proposed measures, a huge mix of intended direct and indirect actions and behavioural changes interlinked across the many actions and measures considered under the policy options. The Strategy also aims to address almost all levels of society and public authorities, and across multiple themes and economic sectors, as the need for adaptation is quite all-encompassing. The impact screening involved consideration of the following channels of action:

Direct behavioural changes

- Obligations to public authorities, particularly Member States, but potentially also other levels, and also private sector organisations. E.g. to produce adaptation strategies, to integrate adaptation in industry standards, etc.;
- Support to organisations, public and private, to take action, e.g. Pilot programmes funded under LIFE, Horizon Europe, or other programmes, policy (technical) support facilities;
- Obligations within EC on mainstreaming of action across policy areas, e.g. inclusion of resilience in major project funding;

Indirect behavioural changes

- Increased information and awareness – including through the production of guidance, development of methodologies, orientation of research programmes, organisation and dissemination of their outputs and solutions, good practices
- Better decision making – by encouraging planning and action, and broadening the knowledge base especially on solutions and good practice

Ultimate impacts on public policy goals

- Increased resilience from greater implementation, from better decisions, based on increased knowledge

As the number and variety of actions and measures under the Adaptation Strategy is high (see Annex 6), the specific impacts of individual measures and actions are too numerous to form the basis of the impact assessment therefore the impacts need to be considered at a higher, aggregated level. Starting from the base list of the Better Regulation Tool we made the following screening, as shown in Table 18.

The results of Q12 of the OPC have been taken into account in this screening, highlighting the importance attached to healthier ecosystems – addressed via the impact indicator on 'Use of ecosystem-based solutions and increased resilience of ecosystems'; on preventing climate risks – addressed as part of the indicator on 'Impact on climate resilience'; and enabling climate-informed decisions by citizens – addressed as part of the impact indicator on 'distributional and equity impacts'.

The results of the interviews are also considered, which identified that the impacts are all linked, and that environmental and social impacts are at least as important as economic impacts for adaptation. Reduced damages were identified as a key economic indicator, and impacts on wellbeing and health were highlighted amongst the social indicators. For economic damages, it may be covered with the Gross Value Added (GVA) indicator, which will reduce with damages, or we consider to potentially also have a damage indicator to sit alongside. Wellbeing is encompassed within the social protection aspect of the impact indicator on 'Distributional and equity impacts', whilst health is covered by both this and the impact indicator on 'impact on public health and civil emergency systems'.

Table 26: Impact screening of key impact indicators

Impact indicator	Relevance	Decision	Method	Indicator
Economic				
Macroeconomic environment	Impacts on the economy are a hugely significant driver for action and reducing damages can be an important indicator of increased resilience.	Included	To be assessed quantitatively with modelling (GWS) and qualitatively.	Economic welfare (losses) (€) And (-/+)
Competitiveness, trade and investment flows	Vulnerability of supply chains to impacts can be relevant and The Strategy will significantly influence the types of investments being made.	Included	Qualitative assessment	Impact on competitiveness, trade and (climate resilient) investments (+/-)
Operation/conduct of SMEs	Strategy is society-wide, but not specifically an economic intervention, SME impacts not a direct goal of the intervention. Attention given to SMEs within other indicators on competitiveness and regulatory burden.	Excluded		
Regulatory burden on business	The Strategy will result in only very limited new obligations on business, the main intention is to encourage, promote and inform own action by businesses. Nevertheless, important to include.	Included	Qualitative assessment	Regulatory burden on business (+/-)
Increased innovation and research	The Strategy will guide research under Horizon Europe, and hopes to encourage greater adoption of innovation.	Included	Qualitative assessment	Impact on adaptation innovation adoption (+/-)
Technological development / digital economy	No significant impact on technological development / digital economy.	Excluded		
Third countries and international relations	The new international objective aims to address EU impact in 3rd countries. The context of this is broader than economic; it is therefore addressed below under crosscutting impacts.	Addressed elsewhere	Addressed as part of an 'Impact on 3rd countries' impact indicator	
Functioning of the internal market and competition	Unlikely to have significant impacts on free movement or competitive markets.	Excluded		
Energy independence	Whilst the Strategy may improve energy infrastructure resilience, the independence aspect is more mitigation related.	Excluded		
Deeper and fairer economic and monetary union	Unlikely to have major impacts on economic and monetary union.	Excluded		

Impact indicator	Relevance	Decision	Method	Indicator
Consumers and households	Strategy hopes to indirectly influence citizens, but more socially/behaviourally than economically. Better addressed under social impacts (income distribution, social protection and inclusion).	Addressed elsewhere	Addressed as part of the income distribution, social protection and social inclusion impact indicator	
Property rights	No significant impact on property rights	Excluded		
Public authorities (and budgets)	The Strategy will significantly impact on public spending on climate resilience, primarily through indirect routes.	Included	Qualitative assessment	Impact on public authorities and budgets (-/+)
Social impacts				
Employment	Impacts on the economy and in-turn on employment are a hugely significant driver for action and reducing damages and job losses can be an important indicator of increased resilience.	Included	To be assessed quantitatively with modelling (GWS) and qualitatively.	Employment (FTE) And (+/-)
Working conditions	Climate change will affect working conditions but the impact is not considered significant in the context of the other impacts.	Excluded		
Income distribution, social protection and social inclusion (of particular groups)	Distributional impacts of climate change can be significant, the Strategy is intended to address and mitigate inequalities, promote wellbeing, including through better informing citizens and encouraging action. Needs to address broader questions of equity (see other impacts) such as location, gender and also of fundamental rights.	Included	Qualitatively	Distributional and equity impacts (+/-)
Public health & safety and health systems	Increased resilience of public health and safety systems is an important goal of the Strategy.	Included	Qualitatively	Impact on public health and civil emergency systems (+/-)
Job standards and quality	Unlikely to be a significant impact	Excluded		
Education and training, education and training systems	Unlikely to be a significant impact	Excluded		
Crime, terrorism and security	Unlikely to be a significant impact	Excluded		
Preserving the cultural heritage / multi-lingualism	Whilst particular locations and buildings of cultural significance may be affected by climate change and the Strategy, this impact is not considered significant in the context of the other impacts nor the proportion of cultural heritage that would be affected.	Excluded		

Impact indicator	Relevance	Decision	Method	Indicator
Governance and good administration	No specific impacts on governance, the increased awareness of citizens may increase participation, but this impact is not considered significant in the context of the other impacts	Excluded		
Environmental impacts				
The climate	Critical impact targeted by the strategy. Increase of resilience to climate impacts, and preventing climate risks. In addition, potential synergies with mitigation may be worth considering.	Included	Qualitatively	Impact on climate resilience (+/-)
Efficient use of resources (renewable & non-renewable)	Strategy will hope to impact on land-use, but rather from a quality than efficiency perspective.	Excluded		
Quality of natural resources/fighting pollution (water, soil, air etc.)	Strategy intends to address impacts of climate change on natural resources, e.g. forests, agriculture, marine environment.	Included	Qualitatively	Impact on natural resource resilience (+/-)
Biodiversity, including flora, fauna, ecosystems and the services they provide and landscapes	Strategy intends to address impacts of climate change on biodiversity and ecosystems functions/services to improve resilience, and to make use of nature-based solutions.	Include	Qualitatively	Use of nature-based solutions and increased resilience of ecosystems (+/-)
Reducing and managing waste	Unlikely to be a significant impact	Excluded		
Minimising environmental risks	Improving the resilience of infrastructure will reduce important environmental risks, but this impact can be addressed indirectly through the indicator on climate resilient investments. Not considered significant enough to evaluate separately in the context of the other impacts	Addressed elsewhere	Addressed within other environmental indicators and the indicator on competitiveness, trade and climate resilient investments	
Protecting animal welfare	Unlikely to be a significant impact	Excluded		
International environmental impacts	Strategy hopes to support improved climate resilience of 3rd countries. But this impact to be assessed in aggregate as part of the Impact on 3rd countries and international relations indicator (see above)	Addressed elsewhere	Addressed as part of the impact on third countries and international relations indicator	
Cross cutting impacts				
Economic and social cohesion (specific regions and sectors)	The distributional effects of climate change are important; the Strategy aims to address these impacts. To be addressed under the umbrella of the distributional and	Addressed elsewhere		

Impact indicator	Relevance	Decision	Method	Indicator
	equity impacts indicator.			
Impacts in developing countries	As highlighted above impacts in developing countries are important to EU economically (supply chains / markets) and socially (family ties, migration, security). Strategy hopes to support improved climate resilience of 3rd (not only developing) countries.	Included	Qualitative assessment	Impact on third countries and international relations (+/-)
Sustainable development	Climate resilience is at the core of sustainable development. Do not propose to assess this impact separately, but would rather point to the overall assessment as an assessment of sustainable development.	Excluded		
Fundamental rights (dignity, freedoms, equality, solidarity, citizens' rights, justice)	The fundamental rights effects of climate change are important; the Strategy aims to address these impacts. To be addressed under the umbrella of the distributional and equity impacts indicator.	Addressed elsewhere	Addressed as part of the income distribution, social protection and social inclusion impact indicator	

Annex 6: Non-exhaustive list of measures to be developed under the new EU Adaptation Strategy

As described in chapter 5, not all measures envisaged under this strategy have been assessed in this impact assessment. The table in this annex lists a more comprehensive, yet not exhaustive list of measures that are considered for the strategy. The measures in green have been subjected to the impact assessment treatment, providing an analysis of the impact of measures based on desk review and impact pathways targeted or expected up to 2050.

Table 27: Non-exhaustive list of measures to be developed under the new EU Adaptation Strategy up to 2050

ACTIONS	MEASURES
POLICY OPTION 1	
1. Closing further gaps in adaptation-relevant knowledge, through systematic data collection and sharing, and working with key public and private partners.	1.1: Ensure broad data collection, exploit new data sources and involve citizens in the collection of data (e.g. citizen science). Promote access to comparable and granular data related to adaptation and climate risks.
	1.2: Develop an research and innovation roadmap and progress the state of the art on adaptation modelling (including agent-based modelling) and risk assessment tools – "Towards asset-level modelling"
	1.3: Develop a spatially explicit assessment of future climate risks, and ecosystems vulnerabilities and shifts under different climate change scenarios.
	1.4: Research supporting wetland and floodplain restoration and nature-based solutions in drought and flood management
	1.5: Close the climate disaster loss and risk data gap through (1) facilitating the recording, collecting and sharing of loss data from public and private sources through standards (2) establishing a climate risk data governance framework and ensuring open access to data, (3) collecting data on direct economic losses, non-economic losses and slow-onset events, and aligning

	existing programmes and data sources.
	1.6 Advancing the digital frontier in adaptation through the Digital Europe Programme and Destination Earth by support the development of federated local data ecosystems and AI-enabled urban data services in cities and, notably through Destination Earth and the deployment of Urban Digital Twins.
	1.7: Closing further knowledge gaps on climate change impacts through Horizon Europe and its Mission on Adaptation to Climate Change, including Societal Transformation.
	1.8: Research into solutions to mitigate and cope with water shortages, including improving desalination technologies
	1.9: Collect data on sustainable water uses disaggregated by sector
	1.10: Develop a comprehensive forest health and resilience module of the Forest Information System for Europe (ENV, EEA), providing interactive maps, downloadable data at country and regional level, and a regular EU forest damage report
	1.11: Ensure that climate monitoring programmes and assets are fully integrated in a legislation proposal for a more efficient and effective marine observation framework in the EU.
	1.12: Ensure that coastal adaptation needs, with local inputs, are well reflected in Member State reports on ocean observation plans.
	1.13: Ensure that all actors involved, e.g. competent authorities, developers of new observation technology, new observation protocols and standards and the private sector, cater for coastal adaptation needs, notably at local level.
2. Further developing Climate-ADAPT as the 'first-stop shop' for adaptation	**2.1: Establish an EU Observatory for climate change and health.**
	2.2: Create an EU-meta observatory on climate impacts, federating various knowledge pools.

information in Europe.	2.3: Increase the usability of, facilitate access to, and leverage synergies from knowledge sources and repositories through updating and expanding the role of Climate-ADAPT as an adaptation monitoring and reporting mechanism. Use the power of networks and provide experts and practitioners with exchange platforms. Showcase and presenting the monitoring results to a broader audience and making the experience gained and lessons learned available to all kinds of stakeholders through reporting.
3. Strengthening the evaluation, monitoring, reporting and implementation of adaptation strategies	3.1: Focus monitoring and reporting systems around a common standard. Establishing an EU climate change resilience framework. Facilitating the monitoring of climate change impacts and adaptation efforts.
	3.2: Progress in implementing the EU Adaptation Strategy through the creation of a monitoring and evaluation framework, including for cities & align the adaptation monitoring and reporting mechanisms.
	3.3: Further upgrade Monitoring Reporting and Evaluation on adaptation at the EU and MS level as mandated by the European Climate Law (and reporting under the National Energy and Climate Plans and the Energy Union Governance Regulation).
	3.4: Use the EU macro-regional strategies cooperation frameworks and the Interreg funding programmes as needed and relevant to strengthen the implementation of climate change adaptation strategies through coordinated and joint actions across borders, between EU Members States and also between EU Member States and non-EU countries.
	3.5: Foster the exchange of best practices and solutions to address common climate adaptation challenges between the outermost regions and their neighbours, and between the outermost regions themselves.

4. Prioritising nature-based adaptation, including coastal protection and green and blue infrastructure.	**4.1: Building inter alia on relevant provisions under the CBD and on the new IUCN Global Standard for Nature-based Solutions, promote the deployment of robust and effective nature-based solutions (NBS) for adaptation to climate change, notably by stepping up and scaling up their implementation and by further developing methods and tools.**
	4.2: Further link insurance products and services to nature-based adaptation efforts.
	4.3: Provide legislative incentives to protect and restore ecosystems with important water cleaning and regulating functions, such as wetlands and floodplains. Promotion of Natural Water Retention. Measures, through legislation if appropriate
	4.4: Improve compliance with Water Framework Directive requirements for good ecological status on floods infrastructure.
	4.5: Update the Natura 2000 and climate change guidance
5. Stepping-up efforts to build resilience in cities and empower local action.	5.1: Strengthen the reporting and planning on adaptation in the Common Reporting Framework of the Covenant of Mayors by refining the Covenant Office work and strengthening awareness and co-benefits of adaptation at city-level.
	5.2: Encourage more involvement of intermediate actors at regional level crucial for urban adaptation.
	5.3: Enable the Covenant of Mayors to focus more on identifying and targeting climate change adaptation in the sectors currently lagging behind in adopting actions, such as the water and health sectors.
	5.4: Launch a climate change adaptation Policy Support Facility / Technical Assistance project supporting local climate change adaptation action through the Covenant of Mayors.
	5.5: Develop a work placement programme for students with experience related to urban planning and resilience, to work in local authorities through the Erasmus+ programme

	5.6: Support vulnerable groups and enterprises through education and reskilling initiatives for green jobs and new business models, including through the European Skills Agenda and European Social Fund Plus (ESIF+), with a particular focus on adaptation and resilience.
	5.7: Study just resilience aspects for access to housing in low risk areas.
	5.8: Promote local climate and energy action through the EU Covenant of Mayors, with an ambition for the initiative to cover 60% of the EU population by 2030
	5.9: Support and encourage regional and local public authorities and employer's organisations to work together with trade unions in mapping and assessing the negative impacts climate change may have on the regional economic environment and workers (health, working conditions, job losses, need for new qualifications); and to promote the adoption of long-term economic diversification strategies and policies that will allow for a requalification and relocation of workers in growth sectors.
	5.10: Make participation in the EU Covenant of Mayors a prerequisite for access to relevant EU financing programmes.
	5.11: Develop a professional training and exchange programme for agricultural and forest planners and practitioners
	5.12: Finance Fisheries Local Action Groups (FLAGs) from EMFF (possibly jointly with other Funds) with a focus on adaptation.
	5.13: Support for adaptation of low-carbon aquaculture farms via BlueInvest and the EMFF
6. Further mainstreaming and integrating adaptation in EU legislation and instruments.	6.1: Actively mainstream adaptation considerations in all European Green Deal initiatives.
	6.2: Strengthen collaboration with all levels of governance in the mainstreaming of adaptation actions.

	6.3: Consider new legislative instruments that recognise and aim to protect workers from the adverse effects of climate change, including exposure to high temperatures
	6.4: Strengthen support for climate proof agriculture and forestry under the Common Agriculture Policy.
	6.5: Include an adaptation analysis in the 2022 report on the Common Fisheries Policy and provide joint guidance for climate resilience of Member States plans under the Marine Strategy Framework Directive and the Maritime Spatial Planning Directive.
	6.6: Include provisions on climate-proof decision making in the legislation on the production and marketing of seed and other propagating material
7. Climate-proofing of Infrastructure and Disaster Risk Management.	7.1: Enhance the climate proofing methodology to address the climate resilience of existing infrastructure, in particular for critical infrastructures and more broadly the built environment underpinning the functioning of the economy and society.
	7.2: Ensure climate-proofing guidelines are applied as widely as possible for the climate resilience of new infrastructures in Europe and abroad.
	7.3: Conduct a study on comprehensive climate risk management approaches and implications for adaptation and Disaster Risk Reduction planning and implementation.
	7.4: Establish an EU-wide climate risk assessment, including a comprehensive risk and vulnerability assessment of critical infrastructures and TEN-T and TEN-E corridors and networks hotspots.
	7.5. Expanding and developing further the work on making standards climate resilient, undertaken under the 2013 Adaptation Strategy on infrastructure standards, in collaboration with the European Standardisation Organisations (ESOs)
	7.6: Improve Member States' preparedness for climate change impacts on floods through the Common

	Implementation Strategy of the Water Framework Directive
	7.7: Enforce Floods Directive requirements for proper land use planning
	7.8: Better addressing storm water overflows and urban runoff under the Urban Waste Water Treatment Directive
	7.9: Introduce reinforced regulatory provisions for the prevention of water pollution through industrial and other (e.g. municipal landfills) accidents caused by flooding and droughts
	7.10: Making existing and future EU energy, transport and ICT infrastructure climate resilient from the point of view of water
8. Closing the Climate Protection gap - microeconomic aspects of adaptation to climate change.	8.1: Introduce a common method to upgrade existing policy instruments: update of the Better Regulation rules and its risk management toolbox to include climate-risk management "policy coherence principles" (i.e. ensure that regulation and funding take into account disaster risk before creating new exposure; reduce existing risk by building up resilience; manage residual financial risk)
	8.2: Funding instruments: mainstreaming of resilience, adaptation and climate risk management concerns in the design of calls and of project selection criteria and the identification of "EU interest" resilience upgrades required for interconnected critical infrastructure.
	8.3: EU policy settings influencing private finance. Focus on the importance of adaptation ambition in the revision of the Non-Financial Reporting Directive and of prudential rules.
	8.4: EU policy settings influencing insurance solutions. Assess climate-friendliness of insurance products development legislation, identify best practises in climate risk underwriting and encourage cross border provision of natural disaster insurance.
	8.5: EU policy settings influencing public finance. Explore "climate resilience" advisory services to contracting authorities and, the mainstreaming resilience in Green Public Procurement. Encourage MSs to report on how disaster aid does not disadvantage those who take insurance coverage/those who do

	not and assess how State Aid to disasters could be modernised as part of the State Aid Review.
	8.6: EU regulatory settings with impact on land use/asset design. Integrate of climate change adaptation into the Strategic Environmental Assessment framework
	8.7: Open an "allies for climate resilience" dialogue gathering the EU (re)insurance industry, public authorities and other relevant stakeholders.
	8.8: Invest in climate risk literacy and improve disaster risk awareness.
POLICY OPTION 2 (i.e. additional to measures listed for Option 1)	
9. Supporting partner countries and regions in their efforts on climate change adaptation and disaster risk management	**9.1: Support upgrade and implementation of NDCs and NAPs , by providing technical and financial assistance dedicated to: building capacity at national and sub-national level; assessing exposure and vulnerabilities; developing adaptation plans in line with national priorities and vulnerabilities; promoting climate-proof structural governance reforms; implementing monitoring and evaluation schemes to assess progress towards climate change resilience; enhancing coherence with national and local disaster risk reduction strategies and environmental sustainability strategies; promoting nature-based solutions and ecosystem-based approaches, especially in coastal areas.**
	9.2: Enhance anticipatory and preventive actions throughout humanitarian and development cooperation programmes, including by promoting ecosystem conservation and restoration and a more systematic use of conflict sensitivity and climate risk analysis and triggers for action, including relevant territorial and investment planning tools.
	9.3: Reinforce support to local authorities, including by enhancing adaptation in urban areas (e.g. through the Global Covenant of Mayors for Climate and Energy), promoting sustainable and resilient urbanisation, supporting communities' engagement in planning and implementation, and channelling of

	financial resources to the local level.
	9.4: Work with leading institutions in Africa, the Caribbean and the Pacific to support regional climate change adaptation and disaster risk management approaches building on ongoing initiatives such as the Africa Adaptation Initiative, and develop regional adaptation plans and action.
	9.5: Launch a regional programme for climate change adaptation and exchanges in the Western Balkans, as well as with EU Southern Neighbourhood countries in line with the Union for the Mediterranean Ministerial Declaration on Environment and Climate Action, and enhance identification and implementation of climate resilience and adaptation measures in the Eastern Neighbourhood.
	9.6: Support data collection, analysis and policy-relevant use, on the climate change – security – migration interconnections by: promoting the use of space based applications, enhancing the role of climate change in the EU Conflict Early Warning System, and integrating climate change adaptation as an instrument towards conflict prevention and resolution with a focus on fragile countries and regions.
	9.7: Support climate change considerations in the works of the relevant Regional Fisheries Management Organisations and Agreements (RFMO/As) within their respective mandates. Continue to table proposals to establish marine protected areas (MPAs) in the Weddell Sea and East Antarctica, respectively, in the Southern Ocean at the Commission of the Conservation of Antarctic Marine Living Resources.
10. Scaling up international adaptation finance and climate disaster risk financing, unlocking innovative finance and mobilising the private sector	10.1: Strive towards achieving a balance between international climate finance for mitigation and adaptation, in line with the Paris Agreement, of at least 50% of international climate finance from the EU budget for external action, on a grant basis, dedicated to climate change adaptation in the 2021-2027 period.
	10.2: Promote the use of innovative financial instruments for climate risks reduction and increase countries' financial resilience to climate related disasters, including by promoting disaster risk financing strategies, risk and forecast based financing for early intervention and joining global initiatives such as InsuResilience Global Partnership.

	10.3: Use the External Investment Plan and the European Fund for Sustainable Development + amongst other innovative financial instruments to leverage private sector finance for climate change adaptation, in line with the EU Sustainable Finance Taxonomy, and promote the engagement of partner countries in the International Platform for Sustainable Finance.
	10.4: Develop guidelines, tools and capacity development actions to support partner countries in the design of policies and incentives towards climate change resilience investments, such as: approaches to mobilising domestic financial resources for climate change adaptation, facilitate access to international climate finance, climate stress testing public and private assets, conducting assessments of portfolios exposure to climate change risks.
	10.5: Enhance climate and sustainability proofing of all EU external investments, including grants, guarantees and blending instruments, by enhancing Environmental and Social Safeguards due diligence, monitoring and follow-up processes.
11. Strengthening EU engagement globally and learning from adaptation frontrunners.	11.1: Submit the EU's Adaptation Plans and actions under the Paris Agreement, in the most appropriate form, and in line with the parity of the importance of adaptation with mitigation.
	11.2: In line with EU climate diplomacy efforts, deepen political engagement with international and regional partners and partner countries, in particular SIDS and LDCs, on climate change adaptation, including by joining and supporting global and regional initiatives on adaptation and resilience, and launching "EU adaptation Dialogues" in key countries, as high level political and business meeting aimed at increasing cooperation on climate change adaptation, achieving a better understanding of adaptation challenges in third countries, and promoting climate change adaptation action and international support.
	11.3: Support exchanges on climate change adaptation knowledge and tools, including by engaging in existing regional and global fora and in initiatives such as Adaptation Futures, and launching a programme of exchange between the EU and third countries on climate change adaptation, such as the EU-Africa Research and Innovation Partnership.
	11.4: Promote adaptation in Green Partnership and Green Alliances with proactive partner countries or regions.

	11.5: Strengthen the production and delivery of, and access to, user-friendly and timely climate data and information (climate services), in particular through the promotion of space based application, the use of Copernicus Climate Change Services and Emergency Management Services in partner countries, thus building on the existing European investments in climate research, data, information and services.
	11.6: In line with EU climate diplomacy efforts, strengthen the role of trade agreements and aid for trade programmes in promoting environmental and climate action in partner countries.
	11.7: Adhesion to the International Coral Reef Initiative.
	11.8: Support the conclusion of an ambitious legally binding agreement on marine biological diversity of areas beyond national jurisdiction (BBNJ) by the end of 2020, in line with the International Ocean Governance agenda
	11.9: Broaden the All-Atlantic Ocean Research Alliance by including more Small Island Developing States of the Atlantic (including the Caribbean).
	11.10: Support climate change considerations in the works of the relevant Regional Fisheries Management Organisations and Agreements (RFMO/As) within their respective mandates. Continue to table proposals to establish marine protected areas (MPAs) in the Weddell Sea and East Antarctica, respectively, in the Southern Ocean at the Commission of the Conservation of Antarctic Marine Living Resources.
12. Adaptation Solutions / Horizon Europe Mission on adaptation to Climate Change, including Societal Transformation	**12.1: Implement the Horizon Europe Mission on Adaptation to Climate Change, including Societal Transformation with the objectives of preparing Europe, Accelerating the transition, and building deep resilience.**
	12.2: Develop forestry and agriculture decision support tools, indicating e.g. trees and crop suitability, weather and climate forecasts and disturbance risks.
	12.3: Facilitate rapid decision-making and enriching toolbox for practitioners through (1) developing solutions for policy makers that allow a rapid analysis to support rapid policy response, (2) developing rapid decision-making tools for cities and citizens, and (3) developing solutions for the business and

	financial sector that allow rapid responses.
	12.4: Horizon Europe mission on Adaptation to Climate to focus on implementing innovative sharing of water resources in specific regions and communities
	12.5: Use results of latest science in projects and studies (.e.g. Gentree, Invite, Liveseed, Sustree, Lifegenmon, GenResBridges) to further improve genetic diversity and the use of plant genetic resources for food and agriculture adaptation, including by implementing relevant parts of the European Genetic Resources Strategy.
13. Closing the Climate Protection Gap - macroeconomic aspects of adaptation to climate change.	**13.1: For public finance/macro financial stability risk: Introduce a step-wise approach whereby the Commission engages a discussion on national disaster risk management frameworks with finance ministers' fora, underpinned by EU level scenario analysis and stress testing. This would lay the ground for mainstreaming the issue climate change in the national fiscal processes.**
	13.2: For reducing the climate-related disaster insurance protection gap. Launch a mechanism to measure, monitor and promote natural disaster insurance penetration in the Member States, which would lead to country level diagnostic assessments and potentially to recommendations to Member States.
	13.3: Break down the climate risk management silos so that reporting requirements from MSs, data specifications and research needs are streamlined and multipurpose.
14. Ensuring the availability of Fresh water.	**14.1: Continue to use the Common Implementation Strategy to improve policy implementation for securing sustainable water use across sectors, through improvements to and intensification of among others: water resource allocation, water-permitting systems, cost recovery through water pricing incorporating externalities, or cost recovery rate calculations.**
	14.2: Coordinate planning across relevant instruments for sustainable water use
	14.3: Improve compliance with existing water legislation with regard to water quantity.

	14.4: Promoting the use of drought management plans more widely in the EU through the Common Implementation Strategy.
	14.3 Reduce exposure to contaminated or acutely polluted water due to climate impacts such as low flows, higher water temperature or flooding, and to ensure availability of adequate quantities of tap water.
	14.6: More ambitious requirements on water saving for products subject to eco-design, energy labelling, ecolabel and green public procurement.
	14.7: Address water saving and reuse in the revised Industrial Emissions Directive and its implementation.
	14.8: Reducing agriculture's water footprint through promoting water reuse and other measures.
	14.9: Addressing water use by the energy sector.
	14.10: Introduce measures supporting zero water new sanitation systems in housing developments/buildings.
	14.11: Promote financing mechanisms to smoothen the transition to higher water prices through water-saving technologies.
	14.12: Develop monitoring services by applying new technologies (such as smart sensors) in a coordinated way.

Annex 7: Mini–Assessments[218]

ACTION 1: Closing further gaps in adaptation-relevant knowledge, through systematic data collection and sharing, and working with key public and private partners.

MEASURE 1.5: Close the climate disaster loss and risk data gap through (1) facilitating the recording, collecting and sharing of loss data from through standards (2) establishing a climate risk data governance framework and ensuring open access to data, (3) collecting data on direct economic losses, non-economic losses and slow-onset events, and aligning existing programmes and data sources.

Baseline, context and rationale

Climate-related disaster loss and climate risk data are important not only for crafting and implementing NAPs and NASs, but also for disaster risk reduction, risk modelling, loss accounting, economic and social policy, EU Solidarity funding, local authority planning, and the provision of green investments. Despite the usefulness of these types of data, they are **not** widely available to public authorities, research institutions, and other stakeholders. The data that is available is often incongruous, lacking the granularity and standardisation required to draw comparisons across regions and Member States, or incomplete, with certain perils missing coverage for the amount of people affected (insured and uninsured), the economic losses (indirect and direct), and the affected areas.

Interviews: In response to Question 2 of the stakeholder interviews (i.e. "What are the main barriers to the EU in the process of adjusting to the adverse effects of climate change?"), several interviewed experts pointed to "Insufficient level of public awareness" (explaining the misperception of increased frequency and intensity of weather events as normal rather than a result of climate change) and "Lack of a single, standardised data collection and recording system for disaster losses.". Another interview group discussed the difficulties with standardisation practices across the EU. In response to question 6A, additional Strategy actions, one expert discussed at length the issue of loss data, "(Actions 1, 4, 5) .1) Information on losses as a public

[218] The mini-assessments provide an analysis of the impact of selected measures based on desk review and impact pathways - the tables below highlight the main impact pathways targeted or expected up to 2050. It is primarily an information tool which addresses weaknesses in understanding risks, vulnerabilities, and possible solutions. In doing so, it improves decision making by actors across sectors. We make a distinction between direct and indirect impacts: Direct impacts – are impacts that directly occur from the implementation of a measure, i.e. water resource allocations are spread more equally across sectors; and Indirect impacts – are impacts that may occur because of the measure, as other stakeholders respond to it, i.e. ecosystems are improved through incorporating externalities in water prices.

good. 2) EEA and EIOPA should be empowered and resourced to be able to monitor and map risks. 3) Transparent reporting mechanisms for climate risks and climate-related disaster losses. 4) Developing EU metrics to evaluate the impacts of adaptation efforts."

OPC: Over half of respondents to the OPC responded that it was very important to support a more open access to climate loss and disaster risk data from private and public sectors (51%) (75% with very important and fairly important combined).

Description of measure

The new Adaptation Strategy aims to become a catalyst to promote consistent and comparable loss data recording, storage, and sharing among Member States. Measures taken in this regard recognise that a governance solution is necessary to promote and ensure the (voluntary) provision of this data and create open repositories for academia, public authorities, and industry partners to utilise loss data more effectively. In addition, it is important that risk models based on such data are transparent in both their underlying data and methodologies.

Objectives and actions

Close the climate-related disaster loss and risk data gaps through the following activities:

(a) Collection of data on direct economic losses, non-economic losses and slow-onset events aligned with existing programmes and databases

(b) Facilitation of the recording, collection and sharing of loss data according to standard methodologies through the creation of a climate (and disaster) loss data mandate: in that context the European Commission should develop harmonised loss recording data standards with and for public and private actors.

(c) Establishment of a climate risk data governance framework, with a consistent taxonomy, and ensured open access to data with the possibility for the European Commission to mandate the recording, collection and sharing of standardised climate-related disaster loss data streams

d) Improved observation of changes in the environment on which the loss data are based that are partly or wholly caused by climate change including a new legislative initiative on ocean observation.

Impact pathways

In the table below impacts are assessed using a scale from (--/-/0/+/++) negative to positive. Impacts are assessed up to 2050 relative to the baseline. It assumes the full uptake of the measure as the increasing severity of physical climate risks is more widely recognized, and consequently the relevance of sharing data.

Table 28: Mini-assessment on Closing further gaps in adaptation-relevant knowledge

Impact indicator	Relevance	Indicator	Baseline	impact pathway	Envisaged impact 2050 (relative to baseline)
Economic impacts					
Macroeconomic environment	Impacts on the economy are a hugely significant driver for action and reducing damages can be an important indicator of increased resilience.	Economic welfare (losses) (-/+)	Economic damages and losses impacts of hazards associated with a changing climate are not well known, and risk models are not able to adequately forecast damages. Risk reduction strategies do not see full potential, and European infrastructure, built environments, and communities face significant annual losses.	Direct impact	More accurate, robust, granular and comparable data leads to better-informed decision making. Areas facing high risk are able to develop more effective risk reduction and adaptation strategies, reducing their vulnerability to damages. The insurance and re-insurance industries are able to better predict insurance premiums and offer products suitable to regions, and collaborate with local authorities where risk cannot/should not be mitigated by insurance alone. **Assessment**: (+)
Competitiveness, trade and investment flows	Vulnerability of supply chains to impacts can be relevant and The Strategy will significantly influence the types of investments being made.	Impact on competitiveness, trade and (climate resilient) investments (+/-)	Supply chains and industries face unmitigated risks to perils and hazard further exasperated by a changing climate. There will continue to be direct damages to physical infrastructure, and indirect losses due to shutdowns and reduced operations during the recovery of events.	Indirect impact	Harmonised climate-related disaster loss data will lead to risk that is more effective reduction measures and bolster adaptation to climate change. Industries are able to better understand, predict, prevent and prepare for their risk thanks to more accurate risk models. Sustainable investment decisions require data, and where disclosure and data exist, there tends to be insight that leads to record investment. For a significant contribution to the adaptation objective in the taxonomy on Sustainable Finance, a risk analysis should be made where this type of collected loss data is one of the key elements. Loss data availability would not only allow models to be more precise, but also provide investors with quantitative information on climate-related losses related to a particular asset. Due to the role of the taxonomy, the impact can be higher than the one of innovation and research. **Assessment:** (++)
Regulatory burden on business	Requirements for open access to data and introduction of new standard frameworks can lead to additional costs for firms.	Regulatory burden on business (+/-)	Financial and insurance sector businesses have some data sharing requirements, but as established processes should not lead to additional costs in the baseline scenario.	Direct impact	Requiring greater provision of data and defining the format and granularity of this data would impose additional costs on firms that hold and would need to provide this data. Affected firms will be mostly large firms concentrated in the financial sector. **Assessment:** (-)

Increased innovation and research	The Strategy will guide research under Horizon Europe and aims to encourage greater adoption of innovation.	Impact on adaptation innovation adoption (+/-)	Climate-related loss data that is not comparable is not useful multiple applications, and hampers both closing the knowledge gap on climate impacts, and research into predictive risk models.	Direct Impact	This measure would provide data that is more precise (clear taxonomy and definitions) comprehensive (total losses including both insured and public losses, for every disaster type, and every sector), comparable (every event is unambiguously defined across databases and data can be aggregated or compared) and transparent (metadata and uncertainty assessment). Such data would benefit decision-making and research reliant on historical climate-related disaster loss data, such as determining vulnerability, establishing baselines, building models to predict future risk, and drawing comparisons between regions and Member States. **Assessment**: (++)
Public authorities (and budgets)	The Strategy will significantly impact on public spending on climate resilience, primarily through indirect routes.	Public spending on adaptation (€)	Public authorities lack the key metrics to make informed decisions on adaptation measures and risk reduction strategies. The current and future costs in terms of economic damages and loss due to climate change are not well understood or known, and thus it is not known how much needs to be budgeted to address these risks.	Direct Impact	The facilitation of harmonised climate-related disaster loss data will ease the reporting burden for Member States and contribute to collecting data once and having it serve multiple initiatives. High-quality climate-related disaster loss data are used as crucial evidence for disaster forensic, which seeks to identify loss drivers to improve DRR measures. Disaster forensic is particularly useful to municipalities and other public authorities, who require high levels of detail to plan risk reduction actions, model risk (both current and ex ante risk and loss models), and develop contingency plans. Thus with the better provision of this data, public authorities are able to mobilise effort to reduce risk, budget for future costs, and more easily apply for Solidarity funding if needed. **Assessment:** (+)
Social impacts					
Employment	Impacts on the economy and in-turn on employment are a hugely significant driver for action and reducing damages and job losses can be an important indicator of increased resilience.	Employment (FTE)	Businesses, especially SMEs, suffer during catastrophic events. Operations can be halted, assets destroyed, and business can slow down in the aftermath of events. The recent COVID-19 crisis has demonstrated the adverse effect hazards and perils can have on employment and the economy in general.	Indirect Impact	Livelihoods, business operations and thus employment can be adversely affected by climate impacts. Establishing vulnerability through the provision of granular, comparable, decision-useful climate-related disaster loss data leads to measures to reduce these adverse effects, establish those in need of solidarity funding, and shorten the amount of time needed for recovery after an event. **Assessment:** (+)
Income distribution, social protection and social inclusion (of	Distributional impacts of climate change can be significant, the Strategy is intended to address and mitigate inequalities, including through better informing citizens and encouraging action. Needs to address	Distributional and equity impacts (+/-)	Those most vulnerable to the impacts of national catastrophes and perils are those on the lower end of the socio-economic spectrum. The exposure of this group to climate change risks is not	Indirect impact	More informed decisions could be taken to provide support to vulnerable groups. More assessable climate-related disaster loss data allows for public authorities to measure the losses not typically captured (due to low insurance penetration) for vulnerable groups and regions. Furthermore, this assists with Solidarity Fund applications, ensuring that losses of vulnerable groups are

particular groups)	broader questions of equity (see other impacts) such as location, economic and social cohesion, gender and of fundamental rights.		fully understood.		captured, and the appropriate level of support is provided. **Assessment:** (+)
Public health & safety and health systems	Increased resilience of public health and safety systems is an important goal of the Strategy.	Impact on public health and civil emergency systems (+/-)	Losses will increase for the next decades without adaptation investments unleashed at scale[219]. Public support systems will be burdened and there will be loss of life and livelihood that could have been mitigated.	Direct impact	Better-informed decisions making because of this measure will lead to increased resilience of public health and safety systems. This is due to being able to accurately determine the impacts of a given event and share this information with local authorities so they are better able to tailor their response and budget for emergencies. Better climate-related disaster loss data also enables citizens to increase their understanding of the impacts of climate change on their community, and take steps and make plans to increase the resilience of their household to relevant perils. **Assessment**: (+)
Environmental impacts					
The climate	Critical impact targeted by the strategy. Increase of resilience to climate impacts and preventing climate risks. In addition, potential synergies with mitigation may be worth considering.	Impact on climate resilience (+/-) *(possible) Synergy with climate mitigation (+/-)*	Climate impacts will continue to threaten all parts of society, and strategies will not be as effective in reducing these impacts due to large knowledge gaps around who is/will be impacted, to what extent, and what can be done.	Direct Impact	Leverage the power of data for increased resilience of society to climate-related risks going forward. Importantly, it also allows broadening the resilience approach beyond climate-related risk information to other risk information such as those from geological, biosafety or environmental risks. **Assessment**: (+)
Quality of natural resources/fighting pollution (water, soil, air etc.)	Strategy intends to address impacts of climate change on natural resources, e.g. forests, agriculture, marine environment.	Impact on natural resource resilience (+/-)		Minimal Impact	

[219] Climate Protection Gap Scoping Report of Working Group 3- Data aspects

Biodiversity, including flora, fauna, ecosystems and the services they provide and landscapes	Strategy intends to address impacts of climate change on biodiversity, and to make use of Ecosystem-based solutions.	Use of ecosystem-based solutions and increased resilience of ecosystems (+/-)		Minimal Impact	
Cross cutting impacts					
Impacts in developing countries	As highlighted above impacts in developing countries are important to EU economically (supply chains / markets) and socially (family ties, migration, security). Strategy aims to support improved climate resilience of 3rd (not only developing) countries.	Impact on third countries and international relations (+/-)		EU Focused	

Some key reports in the field

- Corbane, C., De Groeve, T., Ehrlich, D., & Poljansek, K. (2015). A European framework for recording and sharing disaster damage and loss data. International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences - ISPRS Archives, 40(3W3), 277–283. https://doi.org/10.5194/isprsarchives-XL-3-W3-277-2015
- De Groeve, T., Poljansek, K., Ehrlich, D., & Corbane, C. (2014). Current status and best practices for disaster loss data recording in EU Member States. https://doi.org/10.2788/18330
- European Environment Agency. (2017). Climate change adaptation and disaster risk reduction in Europe. Enhancing coherence of the knowledge base, policies and practices. In EEA Report (Issue 15). https://www.eea.europa.eu/publications/climate-change-adaptation-and-disaster
- European Environment Agency. (2019). Economic losses from climate-related extremes in Europe. https://www.eea.europa.eu/ds_resolveuid/IND-182-en
- Faiella, A., Antofie, T., Luoni, S., Ríos Díaz, F., & Marin Ferrer, M. (2020). The Risk Data Hub loss datasets. https://doi.org/10.2760/488300

- Joint Research Centre. (2015). Guidance for Recording and Sharing Disaster Damage and Loss Data. JRC Science and Policy Reports, 28. https://doi.org/10.2788/186107
- Integrated Research on Disaster Risk. (2014). Perils Classification and Hazards Glossary (IRDR DATA Publication No. 1).
- Marín Ferrer, M., Do Ó, A., Poljanšek, K., & Vallés, A. C. (2018). Disaster damage and loss data for policy: Pre- and post-event damage assessment and collection of data for evidence-based policies. https://doi.org/10.2760/840421
- Marín Ferrer, M., Antofie, T., Eklund, G., & Luoni, S. (2019). THE DISASTER RISK MANAGEMENT KNOWLEDGE CENTRE – RISK DATA HUB: Vision Paper & Roadmap. https://drmkc.jrc.ec.europa.eu/doc/18150
- Ríos Díaz, F., & Marín Ferrer, M. (2017). Loss database architecture for disaster risk management. https://doi.org/10.2760/647488
- Schneiderbauer, S., Calliari, E., Eidsvig, U., & Hagenlocher, M. (2017). The most recent view of vulnerability. Science for Disaster Risk Management 2017: Knowing Better and Loosing Less, 68–82. https://doi.org/10.2788/688605
- UNDRR (2015). Global Assessment Report on Disaster Risk Reduction (GAR).
- UNDRR (2017). Technical Guidance for Monitoring and Reporting on Progress in Achieving the Global Targets of the Sendai Framework for Disaster Risk Reduction, https://www.unisdr.org/files/54970_techguidancefdigitalhr.pdf
- Whitaker, D., Genillard, C. (2020). H2020 Oasis project and its implications for the future of EU policy to promote climate adaptation and understanding of risk for all.

ACTION 2: Further developing Climate-ADAPT as the 'first-stop shop' for adaptation information in Europe.

MEASURE 2.1: Establish an EU Observatory for climate change and health

Baseline, context and rationale

Climate change is already affecting health of human beings, animals and plants, and this will get worse over time, scaling with climate impacts (heatwaves, forest fires, floods, landslides, food and water safety, pests and diseases, and more). Specific vulnerable groups exist, especially low income, children, elderly, and those with existing medical conditions. Climate will also affect public (and private) health systems and their ability to function effectively. Equally, for plant health and the environment where effects of climate change will challenge the resilience of phytosanitary services and agri-food systems to cope effectively with new emerging pests and diseases.

Public health competence is national, so the main channel for EU action is not direct; it needs to act indirectly through supporting / promoting action by Member States. The virtual observatory intends to build on and connect existing initiatives in the areas of climate, health and environment under a single platform to bring knowledge together to help bridge the gaps and deficiencies. Improving knowledge to fill gaps and better connecting the knowledge that is available, but dispersed across organisations and places, can improve insights and (Member States and others) responses, increasing resilience.

A global report/tool does already exist – The Lancet Countdown on Health and Climate Change[220] - launched in 2015, and publishing annually, with a report and data explorer dashboard. This tracks 41 indicators relevant for climate change and health across 5 domains: climate change impacts, exposures, and vulnerability; adaptation planning and resilience for health; mitigation actions and their health co-benefits; economics and finance; and public and political engagement. In terms of preparedness it identifies (not EU specific) around half of countries have a national health and climate plan, but comprehensiveness, scope, update status, and implementation remain major challenges, as does financing. It notes climate information services are not usually informing policy (only 4 of 47 WHO members). According to indicator 2.2 of the Lancet Countdown, 22 European countries provide some climate information services for health. Spending on health and adaptation is increasing (see Fig 11 of the 2019 report), is around €3-€4 per capita annually in Europe. It is somewhat cumbersome to filter for EU only data and some indicators are not as relevant as for developing countries – therefore there can be some value in an EU-focused dashboard. Lancet Countdown would be a partner in the development of the Observatory to bring lessons across and potentially an EU-focused pilot in early 2021.

[220] https://www.lancetcountdown.org/

Various EU tools exist which provide part of the data needs, and could be target for connection and integration in the Observatory, e.g. C3S European Health Service, many of these have already been identified as part of a concept paper for the Health Observatory.

Many stakeholders identified health as an important sector and theme for adaptation, and noted the potential synergies/opportunity presented by COVID19 to increase resilience in this area. The impacts on vulnerable groups, and in particular the possibility to identify and cater for specific vulnerabilities and distributional effects of climate change impacts, were identified as a specific potential benefit.

OPC: The public responses were positive on the importance of health and climate change, yet less so than the experts. This could point to a possible lack of awareness. Response to Q10 suggested health was important, e.g. further action agreed by around 80% of respondents, which is a little less than Water, Agriculture, Energy, Transport, Water and Ecosystems. Q12 importance of impact, improved health, social cohesion and resilience was noted as very important by around 60% of respondents, ranking 4th of 11 impacts, behind Healthier ecosystems, enabling climate-informed decisions by citizens and preventing climate risks.

Description of measure

A virtual observatory with strong contribution from other EU Agencies such as ECDC and EFSA, and hosted by EEA on Climate-ADAPT, aiming to pool relevant work, knowledge and expertise especially from across the Commission, but also from other technical experts (WHO, EFSA, ECDC, C3S, UN agencies such as FAO/IPCC, Lancet) in a multi-disciplinary platform based on the 'One Health' approach – addressing not only human health, but also animal and plant health. Aims are (1) to monitor, analyse, assess, anticipate, prevent, address and communicate effects of climate change on human health; (2) Improve knowledge base for better-informed decision-making; and (3) raise awareness of the health benefits of climate adaptation policies in the relevant fields. Based on the experiences of the Climate-ADAPT evaluation, the coordination function across sectors and across Europe as well as across all governance levels is an important benefit of Climate-ADAPT - since the Health observatory would be embedded in Climate-ADAPT, it would also benefit from the added value of a multi-governance approach. Expected primary users are EU and Member State institutions.

Objectives and actions:

- Gathering evidence on climate change and health – by expanding information, developing new methods and tools, gathering good practices – specific actions include: produce an annual report, preparation of GIS and data mapping
- Enhance climate change preparedness in health systems across Member States and policy – by conducting situation analyses, improving early warning and rapid response capacities with relevant information, analysing the political, socio-economic and financial dimensions, assessing cost-efficiency of measures, integrating existing monitoring and early warning systems keeping into account the One Health approach when relevant–

specific actions include: updating guidance on heat and health, country factsheets on policies, links to warning systems, handbook on vulnerability and impacts, integration with health reporting and other relevant sources of information.

- Build, manage and scale up the observatory portal – by adjusting and further developing the content and functionalities of Climate-ADAPT – specific actions include: integrating an explorer into the portal, develop the structure and web-pages, combine GIS info and statistics, regular maintenance and further development of databases, development of case studies and adaptation options (and interlink them), and develop and decision-making tools.
- Connect knowledge providers with target groups – by making target groups aware of the launch of the observatory, creating perception of trust in it as source, securing return visits to site and contributions / subscriptions – specific actions include: adjusting Climate-ADAPT newsletter, climate code for citizens, factsheet for general public on heatwaves and health, highlighting observatory, presenting observatory at relevant working groups.

Cost

The observatory would start with a pilot in early 2021 based on partner contributions; further decision leading to the full-fledged observatory will be taken in 2021 following a review.

Impact pathways

The table below notes the main impact pathways targeted or expected up to 2050 for the observatory, which is primarily as an information tool which aims to address weaknesses in understanding and knowledge of vulnerabilities, risks and solutions and in doing so lead to better informed decision making by actors across the EU health systems. It is assumed that the demand for health information will further increase, as the severance of physical climate risks increases, and consequently the relevance of sharing data. This is also hoped to (indirectly) spur action by Member States, sectors and within the EC, in doing so it can help to increase resilience and reduce impacts for vulnerable groups.

In the table below impacts are assessed using a scale from (--/-/0/+/++) negative to positive. Impacts are assessed relative to the baseline.

Table 29: Mini-Assessment of Health Observatory

Impact indicator	Relevance	Indicator	Baseline (health and climate)	Health Observatory impact pathway	Envisaged impact 2050 (relative to baseline)
Economic impacts					
Macroeconomic environment	Impacts on the economy are a hugely significant driver for action and reducing damages can be an important indicator of increased resilience.	Economic welfare (losses) (-/+)	Modelled baseline: losses to productivity / from absences due to health conditions. Scaling with temperature increase scenario.	Indirect impact – economic benefits of reduced productivity and sickness losses from Member States action prompted by Observatory.	Included in modelling results for Option 1 in chapter 6. This measure will improve data on health importance and impacts, and is expected that this will stimulate (some) additional spending and planning by Member States. It will lower the productivity decreases from heat waves and heat stress. Additional investment is assumed by the health sector. Through this, the observatory is likely to exert some small influence on the economy indirectly. **Assessment:** Quantitative results included in Option 1 results in chapter 6, qualitative assessment (0/+)
Competitiveness, trade and investment flows	Vulnerability of supply chains to impacts can be relevant and The Strategy will significantly influence the types of investments being made.	Impact on competitiveness, trade and (climate resilient) investments (+/-)	Minimal impact	Minimal impact	
Regulatory burden on business	Measure unlikely to significantly impact on firms.	Regulatory burden on business (+/-)	Minimal impact.	Minimal impact	
Increased innovation and research	The Strategy will guide research under Horizon Europe, and aims to encourage greater adoption of innovation.	Impact on adaptation innovation adoption (+/-)	Minimal impact	Direct impact Increased availability and accessibility of health and climate change data will facilitate and spur additional research and innovation.	Small positive impact on innovation and research assessed. **Assessment:** (+)
Public authorities (and budgets)	The Strategy will significantly impact on public spending on	Public spending on adaptation (€)	Current situation: lack of awareness, information and spending on climate	Indirect impact Hope is that observatory will	Health is becoming an increasing priority on the basis of COVID. Expectation is that health resilience budgets will

	climate resilience, primarily through indirect routes.		and health – unlikely to scale much with temperature scenarios. Knowledge is dispersed, not consistently reaching decision makers – information tools not influencing spending. Indicator 2.4 of Lancet Countdown and WHO survey can help provide baseline e.g. €3-€4/per person spent on this issue. COVID19 will likely result in baseline scenario of significant increase in investments in public health systems preparedness in coming years – will not necessarily address climate risks.	spur additional spending by public authorities on health and climate resilience.	significantly increase in baseline in any case. Question of how much consideration climate may receive in any case (baseline) and how much influence the EU Observatory may have. Evidence from WHO survey shows that health and climate information tools do not tend to influence policy and spending. The planned actions under the observatory do include consideration of these aspects and plans to connect to decision makers. It could therefore be expected for the measure to exert a (minor) influence in increasing public spending on climate change and health, ensuring that it finds a place in the review and improvement of health systems in the COVID aftermath. **Assessment:** not monetised, but positive (+), may increase in high temperature (3°C / 4.5°C) scenarios (+/++)
Social impacts					
Employment	Impacts on the economy and in-turn on employment are a hugely significant driver for action and reducing damages and job losses can be an important indicator of increased resilience.	Employment (FTE)	Minimal impact	Minimal impact	
Income distribution, social protection and social inclusion (of particular groups)	Distributional impacts of climate change can be significant, the Strategy is intended to address and mitigate inequalities, including through better informing citizens and encouraging action. Needs to address broader questions of equity (see other impacts) such as location, economic and social cohesion, gender and of fundamental rights.	Distributional and equity impacts (+/-)	Current situation: health inequalities across EU, different vulnerabilities. Likely to change / increase with temperature scenarios. COVID is exacerbating inequalities, and will leave legacy of vulnerable people, but also tried and tested mechanisms to shield these.	Indirect impact Vulnerable groups' situation will be highlighted, and will benefit from any action spurred by Observatory.	Observatory will draw attention to variety of vulnerabilities by location, age, income, gender and other aspects. Likely to also show how these increase with temperature scenario. Will improve information and add weight to cases within Member States to target their planning and actions. Some Member States will already have plans and better national understanding, some may not use the tools. Expect some (minor) influence on Member States action. Will improve information available to citizens, providing a resource they can use, although they are not a specific target group of the Observatory. **Assessment:** Positive impact (+), likely increasing in high temperature (3°C / 4.5°C) scenarios (++) as it details increasing vulnerabilities.

Public health & safety and health systems	Increased resilience of public health and safety systems is an important goal of the Strategy.	Impact on public health and civil emergency systems (+/-)	Current situation: weaknesses in systems exist – see WHO survey, only half of countries have plan, and of these, many not well implemented or financed. May result in unnecessary loss of life / ill health due to climate impacts (extreme events & slow onset). Will scale (increase) with temperature scenario. Knowledge is dispersed, not consistently reaching decision makers.	Targeted direct impact. Measure intends to lead to better-informed decision making by Member States institutions responsible for health.	Observatory will bring together key data from EU level and expert technical partners, and connect this to target groups in health systems and institutions. This should help to bridge knowledge gaps, identify and target further needs, and result in sharing of solutions and good practice. **Assessment:** Positive impact (+), likely increasing in high temperature (3°C / 4.5°C) scenarios (++) as application of knowledge will help to mitigate increasing damages.
Environmental impacts					
The climate	Critical impact targeted by the strategy. Increase of resilience to climate impacts and preventing climate risks. In addition, potential synergies with mitigation may be worth considering.	Impact on climate resilience (+/-) *(possible) Synergy with climate mitigation (+/-)*	Current situation: no specific measures in place to address health and climate issues (although various local heat wave warning systems in place). Resilience deficiency will scale (increase) with temperature – will be reflected especially in the public health indicator. COVID will result in increased focus on health system resilience; will likely factor in climate considerations for spread of disease, but not other considerations.	Targeted indirect impact. Measure intends to improve climate resilience of health systems.	Aggregating across other impacts, observatory and its indirect impacts will influence increased climate and health resilience across the EU. **Assessment:** Positive impact (+), likely increasing in high temperature (3°C / 4.5°C) scenarios (++). *Possible synergy with climate mitigation* Assessment: no impact
Quality of natural resources/fighting pollution (water, soil, air etc.)	Strategy intends to address impacts of climate change on natural resources, e.g. forests, agriculture, marine environment.	Impact on natural resource resilience (+/-)	No impact	No impact	
Biodiversity, including flora, fauna, ecosystems and the services they provide and	Strategy intends to address impacts of climate change on biodiversity, and to make use of Ecosystem-based solutions.	Use of ecosystem-based solutions and increased resilience of	No impact	No impact	

landscapes		ecosystems (+/-)			
Cross cutting impacts					
Impacts in developing countries	As highlighted above impacts in developing countries are important to EU economically (supply chains / markets) and socially (family ties, migration, security). Strategy aims to support improved climate resilience of 3rd (not only developing) countries.	Impact on third countries and international relations (+/-)	No impact, is EU focused	No impact, is EU focused	

Some key reports in the field

- European Commission (2020): Scientific opinion 'Adaptation to health effects of climate change in Europe' https://ec.europa.eu/info/publications/adaptation-health-effects-climate-change-europe_en
- EASAC (2019) 'Climate action urgently required to protect human health in Europe' https://easac.eu/projects/details/climate-change-and-health/
- The Lancet Countdown (2019): Report of on health and climate change: ensuring that the health of a child born today is not defined by a changing climate
- WHO (2018): Public health and climate change adaptation policies in the European Union. Final report. www.euro.who.int/en/health-topics/environment-and-health/Climate-change/publications/2018/public-health-and-climate-change-adaptation-policies-in-the-european-union-2018
- EEA (2018) Unequal exposure and unequal impacts: social vulnerability to air pollution, noise and extreme temperatures in Europe. EEA Report No 22/2018
- The 2018 report of the Lancet Countdown on health and climate change: shaping the health of nations for centuries to come. 2018 http://dx.doi.org/10.1016/S0140-6736(18)32594-7
- US Fourth national climate assessment, 2018, Volume II: Impacts, risks, and adaptation in the United States. Chapter 14 Human Health https://nca2018.globalchange.gov/chapter/14/

ACTION 3: Strengthening the evaluation, monitoring, reporting and implementation of adaptation strategies at national and subnational levels, including in cities, cross-border, and in the Outermost Regions (including through the Climate Law via Climate-ADAPT).

NO MEASURE impact assessed for Action 3

ACTION 4: Prioritising nature-based adaptation, including coastal protection and green and blue infrastructure.

MEASURE 4.1: ***Building inter alia on relevant provisions under the CBD and on the new IUCN Global Standard for Nature-based Solutions, promote the deployment of robust and effective nature-based solutions (NBS) for adaptation to climate change, notably by stepping up and scaling up their implementation and by further developing methods and tools.***

Baseline, context, and rationale

Climate change and biodiversity loss are linked and interdependent. We can only achieve climate, biodiversity and sustainable development goals if we scale up and speed up the implementation of technological, societal and nature-based solutions. There is growing global consensus on the importance of addressing these challenges (and the wider set of Sustainable Development Goals) in an integrated manner and, consequently, on the urgency of identifying and implementing win-win solutions.

Nature-based solutions (NbS), actions that conserve, manage or restore nature to support biodiversity to help address societal challenges, empower people and provide job and business opportunities can be powerful tools for combatting biodiversity loss and supporting climate change mitigation and/or adaptation and disaster risk reduction while delivering further benefits to human well-being (e.g. health). NbS are based on the principle that ecosystems in healthy condition deliver multiple benefits and services for human well-being and can thereby address economic, social and environmental goals simultaneously. Depending on their context, NbS are also framed as Ecosystem-based Adaptation (EbA), Green Infrastructure (GI), Ecosystem-based Disaster Risk Reduction (EcoDRR), or Natural Water Retention Measures (NWRM).

Despite the fact that ecosystem-based solutions have proved to be cost-efficient policy approaches to address climate change adaptation, they are yet not used fully.[221] Reasons for this relatively low uptake are multiple (e.g. cultural perceptions, knowledge gaps, low guidance), and have driven to, among others, unevenness of climate adaptation action across Member States.

In 2017, though the interest for the ecosystem-based adaptation concept is increasing in different areas, it has mainly been applied in the agriculture and forestry sectors; and therefore, experts continuously have advocated for supporting legislation that enables its systematic mainstreaming into urban planning, i.e., incorporating its principles into relevant policies and planning tools across sectors. .[222] Since then, both development and implementation of NbS have significantly increased. Nonetheless, there is still a large gap between the research efforts concerning small- (i.e. at urban or local scale such as filter drains, porous pavements, green roofs, etc.) and large-scale NbS (i.e. solutions which are applied in rural and coastal areas, river basins and/or at the regional scale such as large retention basins, lakes, flood plains, wetlands, beach nourishment, etc.).[223]

During the targeted stakeholder consultation activities undertaken in the framework of this study it was indicated that, besides funding support, the EU should promote the development of standard methodologies to quantify the costs and benefits of ecosystem-based approaches, in order to help with the implementation of solutions. Projects supported under consecutive EU research framework programmes have investigated in these issues and results are made available in a series of reports. [224] Stakeholders also suggested the Strategy could support a dedicated mechanism to provide tailored adaptation guidance and peer-to-peer knowledge sharing for local public authorities and non-state actors. The upcoming EEA report on nature-based solutions – ecosystem-based approaches to climate change adaptation and disaster risk reduction partly fulfils this request.[225] Moreover, many stakeholders referred to the importance of ecosystem-based adaptation to increase the resilience of the infrastructural sector, for example in the context of coastal protection. The COVID 19 crisis has further amplified the importance of resilience and the importance of having access to nature for general well-being.

[221] European Commission (2019). Review of Progress on the Implementation of the EU Green Infrastructure Strategy. SWD (2019) 184 final.
Retrieved from: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52019DC0236&qid=1562053537296
[222] Pauleit, S. et. al (2017). Nature-based solutions and climate change–four shades of green. In Nature-Based Solutions to Climate Change Adaptation in Urban Areas (pp. 29-49). Springer, Cham.
[223] European Commission (2020) Nature-based solutions for flood mitigation and coastal resilience
[224] See sectorial reports: https://ec.europa.eu/info/news/new-publication-what-nature-based-solutions-can-do-us-2020-jul-16_en
[225] EEA (forthcoming) Nature-based solutions and ecosystem-based approaches to climate change adaptation and DRR in Europe

OPC: Respondents to the OPC reported that one of the main actions to support resilience building is information/guidance about management practices and nature-based solutions. During the interviews, stakeholders also highlighted the importance of NbS and recommended to give NbS interventions similar priority as for the Strategy's eight existing actions.

Description of measure

This measure of the new strategy seeks greater prioritising/promoting of nature-based solutions- ecosystem-based adaptation in relevant areas (see References below). This will be achieved through scaling up and stepping up the implementation of nature-based solutions and ecosystem-based approaches.

Objectives and actions:

This measure seeks to enhance NbS, including coastal protection, through their wider adoption and upscaling of blue and green infrastructure. Building inter alia on relevant provisions under the CBD and on the new IUCN Global Standard for Nature-based Solutions[226], promote the deployment of robust and effective nature-based solutions (NbS) for adaptation to climate change by developing methods and tools to

a) assess the vulnerability and expected resilience of planned NbS to projected climate change;

b) determine their cost-efficiency and effectiveness with regards to their expected adaptation functions;

c) quantify their wider economic, social and environmental co-benefits.

Guide the introduction of decision criteria when assessing adaptation strategies that allow to include multiple benefits in order to promote nature-based solutions-ecosystem-based approaches, in accordance with the EU Biodiversity and EU Forest Strategy.

Use public tendering to stimulate the deployment of ecosystem-based solutions by, for instance, sponsoring the building of green infrastructure in public buildings (EU Procurement Guides)

[226] Relevant provision include: Assessing the impacts of climate change on biodiversity (UNEP/CBD/COP/DEC/X/33); Voluntary guidelines for the design and effective implementation of ecosystem-based approaches to climate change adaptation and disaster risk reduction (CBD COP 14/5) (CBD/SBSTTA/22/INF/1); Guidance on enhancing positive and minimizing negative impacts on biodiversity of climate change adaptation activities (UNEP/CBD/SBSTTA/20/INF/1); Synthesis report on experiences with ecosystem-based approaches to climate change adaptation and disaster risk reduction (CBD Technical Series N° 85)

Amplify and consolidate capacity building and experience exchange among rural, coastal and urban practitioners, to incentivise the shift from the traditional bias towards built infrastructure to nature-based solutions-ecosystem-based approaches, including practitioners from other regions (e.g. Global South) where NbS have been successfully implemented.

Advance in the study of the climate resilience of the NBS, ensuring that the new NBS/infrastructures are climate-resilient, which would also incentive investments from the private sector.

Further linking insurance products and services to nature-based solutions -ecosystem-based approaches adaptation, which may offer several financial opportunities for the risk industry (e.g. by reducing insured losses, creating new insurance opportunities).

The results of this work will be used to inform and guide all relevant EU funding and investment programmes, to support the implementation of the network of protected areas and of the EU Nature Restoration Plan under the Biodiversity Strategy for 2030 (including the legally binding restoration targets; the new EU Forest Strategy, the EU Soil Thematic Strategy, the EU Urban Greening Platform), and to contribute to the European Climate Pact.

Cost

The EU Biodiversity Strategy[227] indicates that actions to tackling biodiversity loss and restoring ecosystems (including NbS) will require significant public and private investments at the national and European levels. Therefore, the Commission estimates that to meet investment priorities for Natura 2000 and green infrastructure, at least €20 billion a year should be unlocked for spending on nature. Specifically, 25% of the EU budget dedicated to climate action will be invested in biodiversity and nature-based solutions.

Impact pathways

In the table below impacts are assessed using a scale from (--/-/0/+/++) negative to positive. Impacts are assessed up to 2050 relative to the baseline. It assumes the full uptake of the measure as the increasing severance of physical climate risks is more widely recognized the benefits from nature-based adaptation become apparent and proven, and consequently the acceleration in the adoption of solutions.

[227] European Commission (2020) EU Biodiversity Strategy for 2030, from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, COM/2020/380 final, available at - https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1590574123338&uri=CELEX:52020DC0380

Table 30: Mini-Assessment of stimulating the deployment of Nature-based solutions

Impact indicator	Relevance	Indicator	Baseline	Impact pathway	Envisaged impact 2050 (relative to baseline)
Economic					
Macroeconomic environment	Impacts on the economy are a hugely significant driver for action and reducing damages can be an important indicator of increased resilience.	Economic welfare (losses) (-/+)	As a recent study by the WEF shows[228], more than half of the world's total GDP is moderately or highly dependent on nature and its services and therefore exposed to nature loss. The three largest sectors that are highly dependent on nature (i.e. construction, agriculture, and food and beverages) generate close to $8 trillion of GVA, and as nature loses its capacity to provide such services, these sectors could suffer significant losses. The study shows that 49% of Europe's GDP is generated through sectors highly (13%) and medium (36%) dependent on nature	Indirect impact	Results are included in modelling in chapter 6. Mainstreaming nature-based adaptation, including coastal protection and green infrastructure is interpreted as stimulating the deployment of nature-based solutions, including through increased use public tendering and guidance for quantifying social and environmental co-benefits and comprises the adaption by retention areas, which has been assessed as very feasible by PESETA IV. If all retention areas suggested there had been triggered by this option, damage reduction of up to 72% were feasible. The possible effects span a wide range: from 80% damage reduction due to retention areas in France, more than 60% for Germany to a mere 9% in Spain. We keep the structure of successes from the adaptation by increasing retention areas and assume that 10% of the respective damage reduction can be triggered. Investment leads to additional demand for the construction sector, because in the sector-specific classifications of Eurostat's Input Output Tables, landscaping is included in the construction sector. Any planning, design and other services are then included in full in the model, due to the input structure and the demand for intermediate goods and services by the respective sectors. The adaptation costs are borrowed from PESETA IV and distributed into the regions proportional to the respective damage reduction, assuming more or less equal costs per reduced damage. **Assessment:** impact is included in modelled results, qualitatively (+)
Competitiveness, trade and investment flows	Vulnerability of supply chains to impacts can be relevant and The Strategy will significantly influence the types of investments being made.	Impact on competitiveness, trade and (climate resilient) investments (+/-)	Large-scale loss of nature has already affected the EU international trade agreements (e.g., forest fires and deforestation in the Brazilian Amazon affecting the EU-Mercosur trade agreement, which is worth €122 billion and expected to generate significant	Minimal impact	

[228] World Economic Forum (2020) Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy. Available at: http://www3.weforum.org/docs/WEF_New_Nature_Economy_Report_2020.pdf

			market opportunities).		
Regulatory burden on business	Rewarding use of NbS in public tendering will incentivise firms to include it in their offers, may require additional efforts. Nevertheless, these would be voluntary. Under the EU Taxonomy, investments are required	Regulatory burden on business (+/-)	Minimal (mandatory) impact	Minimal impact	
Increased innovation and research	The Strategy will guide research under Horizon Europe and aims to encourage greater adoption of innovation.	Impact on adaptation innovation adoption (+/-)	According to the latest review of the state of the art of EU-funded projects, the relevant NBS strands of the Horizon 2020 programme include 35 projects with a total budget of €288m, delivered within dedicated focus areas e.g. 'Smart and Sustainable Cities with NbS. Further investments in NbS research and innovation have been delivered through other EU instruments (e.g. COST, ERDF, LIFE+ and EIB's Natural Capital Financing Facility). Furthermore, H2020 calls for proposals on NbS have been oversubscribed with nearly 300 proposals received for 11 call areas relating to NBS.[229] In parallel, as part of the EU Biodiversity Strategy the Commission will promote and facilitate partnerships, including a dedicated Biodiversity Partnership, to facilitate the bridge between science, policy and practice in regards to nature-based solutions. [230]	Direct impact	The Horizon Europe Missions on Adaptation to Climate Change will aim to boost nature-based solutions and green-blue multipurpose infrastructure investments in ecosystems. [231] By promoting the deployment of NbS, this measure of the new Strategy is expected to incentivise the research in NbS and encourage the adoption of NbS-related innovative measures in cities. **Assessment: Positive impact (+)**

[229] European Commission (forthcoming) Nature-based solutions- State of the art in the EU-Funded projects.
[230] European Commission (2020) EU Biodiversity Strategy for 2030, from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, COM/2020/380 final, available at - https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1590574123338&uri=CELEX:52020DC0380
[231] European Commission (2020) "Accelerating the Transition to a Climate Prepared and Resilient Europe Interim report of the Mission Board for Adaptation to Climate Change, including Societal Transformation" Available at: https://op.europa.eu/en/publication-detail/-/publication/1d5234b9-b68a-11ea-bb7a-01aa75ed71a1

Public authorities (and budgets)	The Strategy will significantly impact on public spending on climate resilience, primarily through indirect routes.	Public spending on adaptation (€)	The structure of municipal revenues is decisive for NBS financing.[232] However, natural infrastructure is still often hampered by budgetary constraints.[233] From the 1 000 examples of NBS from 100 EU cities included in the Urban Nature Atlas[234]! developed by the NATure-based URban innoVATION project, 49% of the projects' financing resources were earmarked public budget. Implementation of the EU Biodiversity Strategy for 2030 and COVID19 recovery could become a game-changer in this respect.	Direct impact	Prioritising and mainstreaming NbS for climate adaptation into local policies is expected to ensure that part of the public budgets is allocated to finance NbS pilot installations, such as green roofs and walls. Moreover, by providing support for the economic valuation of NBS and the multiple benefits they deliver (e.g. clean air, habitat for nature, CO2 sequestration), sufficient public resources will be ensured not only for the implementation but also for the adequate maintenance of the NbS. In addition, following the EU Biodiversity Strategy, this measure is expected to support the development of Urban Greening Plans by the end of 2021. In addition, using the EU sustainable finance taxonomy as a reference, it is expected to help guide investment towards a green recovery and the deployment of NbS. **Assessment: Positive impact (++),**
Social impacts					
Employment	Impacts on the economy and in-turn on employment are a hugely significant driver for action and reducing damages and job losses can be an important indicator of increased resilience.	Employment (FTE)	NbS have shown to benefit the creation of jobs and to stimulating innovation for a green economy.[235] Today, in Germany 6 % of total employment relies directly on ecosystem services; while in the European Union (EU) as a whole the proportion is as high as 16 %[236]	Indirect impact	This measure aims to amplify and consolidate capacity building and experience exchange among practitioners, and it is, therefore, expected to incentivise the shift from the traditional bias towards built infrastructure to NbS approaches. This transformation is expected to stimulate the creation of new jobs. **Assessment:** Positive impact (+)
Income distribution, social protection, and social inclusion (of particular	Distributional impacts of climate change can be significant, the Strategy is intended to address and mitigate inequalities, including through better-informing citizens and encouraging action. Needs to address broader questions of equity (see other impacts) such as location, economic and social	Distributional and equity impacts (+/-)	As shown by a recent Horizon 2020 study, access to healthy natural environments is especially important for vulnerable populations, which makes NbS key to reducing inequalities within and between societies (SDG 10) and	Indirect impact	By consolidating the knowledge and tools used to assess NbS, more informed decisions can be taken to support vulnerable groups. The acknowledgment of the potential positive impact of NbS on reducing inequalities and promoting social inclusion is expected to incentivise NbS adaptation approaches in cities.

[232] Droste, N. et. al (2017). Implementing nature-based solutions in urban areas: financing and governance aspects. In Nature-based solutions to climate change adaptation in urban areas (pp. 307-321). Springer, Cham.
[233] van Ham, C., & Klimmek, H. (2017). Partnerships for nature-based solutions in urban areas–showcasing successful examples. In Nature-Based Solutions to Climate Change Adaptation in Urban Areas (pp. 275-289). Springer, Cham.
[234] See https://naturvation.eu/atlas
[235] Kabisch, Nadja, et al. (2017) Nature-based solutions to climate change adaptation in urban areas: Linkages between science, policy and practice. Springer Nature.
[236] ILO (2018) "The employment impact of climate change adaptation". Input Document for the G20 Climate Sustainability Working Group International Labour Office – Geneva,

groups)	cohesion, gender, and of fundamental rights.		improving health and well-being (SDG3).[237] Regarding social inclusion, NbS have proven to be an effective means to build processes and practices for sustainable communities, with many NbS projects giving attention to how to involve groups such as refugees, young people and women.[238]		**Assessment:** Positive impact (+)
Public health & safety and health systems	Increased resilience of public health and safety systems is an important goal of the Strategy.	Impact on public health and civil emergency systems (+/-)	The effect of NbS in reducing the urban heat effect (UHI) is only one example of how NBS can benefit public health, which has been studied in different European countries. For instance, the EU-RAMSES project found that in northern cities increasing green areas from the current 25% to 60% would allow an average cooling of around 0.6°.[239] In addition, it has been shown that crime prevention can be significantly improved by green infrastructure development.[240]	Indirect impact	By providing evidence of the multiple benefits that NbS deliver regarding public health and safety systems (e.g. heat stress, air pollution, and crime prevention) is expected that city governments and communities be encouraged to support NbS interventions. **Assessment:** Positive impact (+)
Environmental impacts					
The climate	Critical impact targeted by the strategy. Increase of resilience to climate impacts and preventing climate risks. In addition, potential synergies with mitigation may be worth considering.	Impact on climate resilience (+/-) *(possible) Synergy with climate mitigation*	There is growing scientific evidence that NbS offer multiple benefits for climate change adaptation and disaster risk reduction in particular for sectors that depend on ecosystems and natural resources (e.g. water), such as forestry and agriculture; in urban areas, NbS are effective in providing benefits for adaptation and disaster risk reduction	Targeted direct impact.	The measure will increase the deployment of NbS and is expected to motivate cities and communities to sign up to more ambitions 2030 targets, and to support the implementation of other NbS-related strategies at the EU level, such as the EU Biodiversity Strategy. The climate impact of the measure is expected to influence both climate adaptation and mitigation in Europe. **Assessment:** Positive impact (++)

[237] Faivre, Nicolas, et al. "Nature-Based Solutions in the EU: Innovating with nature to address social, economic and environmental challenges." Environmental research 159 (2017): 509-518.
[238] European Commission (2020) Nature-based solutions towards sustainable communities
[239] European Commission (2020) Nature-based solutions for microclimate regulation and air quality
[240] Shepley, Mardelle, et al. "The impact of green space on violent crime in urban environments: An evidence synthesis." International journal of environmental research and public health 16.24 (2019): 5119.

		(+/-)	(e.g. reducing damage from heavy precipitation and flooding, alleviating impacts of droughts and heat-related challenges)[241] Moreover, NBS can contribute to climate mitigation through both storing and sequestering carbon and reducing energy demand (e.g. by improving thermal comfort cities and promoting the use of walking and cycling routes).[242]		
Quality of natural resources/fighting pollution (water, soil, air, etc.)	Strategy intends to address impacts of climate change on natural resources, e.g. forests, agriculture, marine environment.	Impact on natural resource resilience (+/-)	NbS interventions such as green roofs can achieve cost-effective reductions in drainage systems, whilst improving urban environmental quality, decreasing nutrient and chemical pollution level[243] Moreover, a number of studies, such as the BRIDGE project, have evidenced the NBS's contribution to removing air pollutants such as O_3, $PM_{2.5}$, NO_X, and SO_2.[244]	Targeted direct impact.	The quality of natural resources (including soil, water, and air) will be positively impacted by the increased adoption of NbS, which will be mainly achieved through prioritising and mainstreaming NbS for climate adaptation at local level. **Assessment:** Positive impact (+)
Biodiversity, including flora, fauna, ecosystems and the services they provide, and landscapes	Strategy intends to address impacts of climate change on biodiversity, and to make use of Ecosystem-based solutions.	Use of ecosystem-based solutions and increased resilience of ecosystems	Several EU-funded projects have identified types of NbS that have offer particularly high benefits for biodiversity. Examples of relevant NBS include renaturing landfill sites, brownfields and river corridors, restoration of catchments and coastal	Targeted direct impact.	The measure is expected to increase the attractiveness and thus deployment of NbS. Based on the identified benefits of NbS, the EU biodiversity will be positively impacted as more NbS interventions are supported. **Assessment:** Positive impact (+)

[241] EEA (forthcoming) Nature-based solutions and ecosystem-based approaches to climate change adaptation and DRR in Europe
[242] European Commission (forthcoming) Nature-based solutions- State of the art in the EU-Funded projects.
[243] European Commission (2020) Nature-based solutions improving water quality and waterbody conditions
[244] European Commission (2020) Nature-based solutions for microclimate regulation and air quality

		(+/-)	landscapes, arboreal interventions, and pollinator sites.[245]		
Impacts in developing countries	As highlighted above impacts in developing countries are important to the EU economically (supply chains / markets) and socially (family ties, migration, security). Strategy aims to support improved climate resilience of 3rd (not only developing) countries.	Impact on third countries and international relations (+/-)	NbS are becoming increasingly important in international agreements and policy frameworks,[246] including the UN Framework Convention on Climate Change and the Convention on Biological Diversity. To support the impact of NBS implementation in third countries, the EU has established different programs such as the *Strengthening international cooperation on sustainable urbanisation: nature-based solutions for restoration and rehabilitation of urban ecosystems.*[247] Specific NBS sector dialogues have also been conducted with successful results, such as the EU – Brazil Sector Dialogue on nature-based solutions.[248]	Indirect impact	Particular measures taken to promote global mainstreaming of NBS include Sector Dialogues, which intend to capitalise upon existing experiences and good practices in Europe and beyond. In accordance, this measure is expected to have an indirect impact in developing countries, as knowledge and experience exchange is incentivised.
Impact indicator	**Relevance**	**Indicator**	**Baseline**	**Impact pathway**	**Envisaged impact 2050 (relative to baseline)**
Economic					
Macroeconomic environment	Impacts on the economy are a hugely significant driver for action and reducing damages can be an important indicator of increased resilience.	Economic welfare (losses) (-/+)	As a recent study by the WEF shows[249], more than half of the world's total GDP is moderately or highly dependent on nature and its services and therefore exposed to nature loss. The three largest sectors that are highly dependent on nature (i.e. construction, agriculture, and	Indirect impact	Results are included in modelling in chapter 6. Mainstreaming nature-based adaptation, including coastal protection and green infrastructure is interpreted as stimulating the deployment of nature-based solutions, including through increased use public tendering and guidance for quantifying social and environmental co-benefits and comprises the adaption by retention areas, which has been assessed as very feasible by PESETA IV. If all retention areas suggested there had been triggered by

[245] European Commission (2020) Biodiversity and Nature-based Solutions
[246] European Commission (forthcoming) Nature-based solutions- State of the art in the EU-Funded projects.
[247] See: https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/sc5-13-2018-2019
[248] European Commission (2019) The EU – Brazil Sector Dialogue on nature-based solutions. Available at: https://oppla.eu/sites/default/files/docs/EU-Brazil-NBS-dialogue-1610.pdf
[249] World Economic Forum (2020) Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy. Available at: http://www3.weforum.org/docs/WEF_New_Nature_Economy_Report_2020.pdf

			food and beverages) generate close to $8 trillion of GVA, and as nature loses its capacity to provide such services, these sectors could suffer significant losses. The study shows that 49% of Europe's GDP is generated through sectors highly (13%) and medium (36%) dependent on nature		this option, damage reduction of up to 72% were feasible. The possible effects span a wide range: from 80% damage reduction due to retention areas in France, more than 60% for Germany to a mere 9% in Spain. We keep the structure of successes from the adaptation by increasing retention areas and assume that 10% of the respective damage reduction can be triggered. Investment leads to additional demand for the construction sector, because in the sector-specific classifications of Eurostat's Input Output Tables, landscaping is included in the construction sector. Any planning, design and other services are then included in full in the model, due to the input structure and the demand for intermediate goods and services by the respective sectors. The adaptation costs are borrowed from PESETA IV and distributed into the regions proportional to the respective damage reduction, assuming more or less equal costs per reduced damage. **Assessment:** impact is included in modelled results, qualitatively (+)
Competitiveness, trade and investment flows	Vulnerability of supply chains to impacts can be relevant and The Strategy will significantly influence the types of investments being made.	Impact on competitiveness, trade and (climate resilient) investments (+/-)	Large-scale loss of nature has already affected the EU international trade agreements (e.g., forest fires and deforestation in the Brazilian Amazon affecting the EU-Mercosur trade agreement, which is worth €122 billion and expected to generate significant market opportunities).	Minimal impact	
Regulatory burden on business	Rewarding use of NbS in public tendering will incentivise firms to include it in their offers, may require additional efforts. However, these would be voluntary.	Regulatory burden on business (+/-)	Minimal (mandatory) impact	Minimal impact	
Increased innovation and research	The Strategy will guide research under Horizon Europe and aims to encourage greater adoption of innovation.	Impact on adaptation innovation adoption (+/-)	According to the latest review of the state of the art of EU-funded projects, the relevant NBS strands of the Horizon 2020 programme include 35 projects with a total budget of €288m, delivered within dedicated focus areas e.g. 'Smart and Sustainable Cities with NbS. Further	Direct impact	The Horizon Europe Missions on Adaptation to Climate Change will aim to boost nature-based solutions and green-blue multipurpose infrastructure investments in ecosystems. [252] By promoting the deployment of NbS, this measure of the new Strategy is expected to incentivise the research in NbS and encourage the adoption of NbS-related innovative measures in cities.

[252] European Commission (2020) "Accelerating the Transition to a Climate Prepared and Resilient Europe Interim report of the Mission Board for Adaptation to Climate Change, including Societal Transformation" Available at: https://op.europa.eu/en/publication-detail/-/publication/1d5234b9-b68a-11ea-bb7a-01aa75ed71a1

			investments in NbS research and innovation have been delivered through other EU instruments (e.g. COST, ERDF, LIFE+ and EIB's Natural Capital Financing Facility). Furthermore, H2020 calls for proposals on NbS have been oversubscribed with nearly 300 proposals received for 11 call areas relating to NBS.[250] In parallel, as part of the EU Biodiversity Strategy the Commission will promote and facilitate partnerships, including a dedicated Biodiversity Partnership, to facilitate the bridge between science, policy and practice in regards to nature-based solutions. [251]		**Assessment: Positive impact (+)**

[250] European Commission (forthcoming) Nature-based solutions- State of the art in the EU-Funded projects.
[251] European Commission (2020) EU Biodiversity Strategy for 2030, from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, COM/2020/380 final, available at - https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1590574123338&uri=CELEX:52020DC0380

Public authorities (and budgets)	The Strategy will significantly impact on public spending on climate resilience, primarily through indirect routes.	Public spending on adaptation (€)	The structure of municipal revenues is decisive for NBS financing.[253] However, natural infrastructure is still often hampered by budgetary constraints.[254] From the 1 000 examples of NBS from 100 EU cities included in the Urban Nature Atlas[255]! developed by the NATure-based URban innoVATION project, 49% of the projects' financing resources were earmarked public budget. Implementation of the EU Biodiversity Strategy for 2030 and COVID19 recovery could become a game-changer in this respect.	Direct impact	Prioritising and mainstreaming NbS for climate adaptation into local policies is expected to ensure that part of the public budgets is allocated to finance NbS pilot installations, such as green roofs and walls. Moreover, by providing support for the economic valuation of NBS and the multiple benefits they deliver (e.g. clean air, habitat for nature, CO2 sequestration), sufficient public resources will be ensured not only for the implementation but also for the adequate maintenance of the NbS. In addition, following the EU Biodiversity Strategy, this measure is expected to support the development of Urban Greening Plans by the end of 2021. In addition, using the EU sustainable finance taxonomy as a reference, it is expected to help guide investment towards a green recovery and the deployment of NbS. **Assessment: Positive impact (++),**
Social impacts					
Employment	Impacts on the economy and in-turn on employment are a hugely significant driver for action and reducing damages and job losses can be an important indicator of increased resilience.	Employment (FTE)	NbS have shown to benefit the creation of jobs and to stimulating innovation for a green economy.[256] Today, in Germany 6 % of total employment relies directly on ecosystem services; while in the European Union (EU) as a whole the proportion is as high as 16 %[257]	Indirect impact	This measure aims to amplify and consolidate capacity building and experience exchange among practitioners, and it is, therefore, expected to incentivise the shift from the traditional bias towards built infrastructure to NbS approaches. This transformation is expected to stimulate the creation of new jobs. **Assessment:** Positive impact (+)
Income distribution, social protection, and social inclusion (of particular	Distributional impacts of climate change can be significant, the Strategy is intended to address and mitigate inequalities, including through better-informing citizens and encouraging action. Needs to address broader questions of equity (see other	Distributional and equity impacts (+/-)	As shown by a recent Horizon 2020, access to healthy natural environments is especially important for vulnerable populations, which makes NbS key to reducing inequalities within and between	Indirect impact	By consolidating the knowledge and tools used to assess NbS, more informed decisions can be taken to support vulnerable groups. The acknowledgment of the potential positive impact of NbS on reducing inequalities and promoting social inclusion is expected to incentivise NbS adaptation approaches in cities.

[253] Droste, N. et. al (2017). Implementing nature-based solutions in urban areas: financing and governance aspects. In Nature-based solutions to climate change adaptation in urban areas (pp. 307-321). Springer, Cham.
[254] van Ham, C., & Klimmek, H. (2017). Partnerships for nature-based solutions in urban areas–showcasing successful examples. In Nature-Based Solutions to Climate Change Adaptation in Urban Areas (pp. 275-289). Springer, Cham.
[255] See https://naturvation.eu/atlas
[256] Kabisch, Nadja, et al. (2017) Nature-based solutions to climate change adaptation in urban areas: Linkages between science, policy and practice. Springer Nature.
[257] ILO (2018) "The employment impact of climate change adaptation". Input Document for the G20 Climate Sustainability Working Group International Labour Office – Geneva,

groups)	impacts) such as location, economic and social cohesion, gender, and of fundamental rights.		societies (SDG 10) and improving health and well-being (SDG3).[258] Regarding social inclusion, NbS have proven to be an effective means to build processes and practices for sustainable communities, with many NbS projects giving attention to how to involve groups such as refugees, young people and women.[259]		**Assessment:** Positive impact (+)
Public health & safety and health systems	Increased resilience of public health and safety systems is an important goal of the Strategy.	Impact on public health and civil emergency systems (+/-)	The effect of NbS in reducing the urban heat effect (UHI) is only one example of how NBS can benefit public health, which has been studied in different European countries. For instance, the EU-RAMSES project found that in northern cities increasing green areas from the current 25% to 60% would allow an average cooling of around 0.6°.[260] In addition, it has been shown that crime prevention can be significantly improved by green infrastructure development.[261]	Indirect impact	By providing evidence of the multiple benefits that NbS deliver regarding public health and safety systems (e.g. heat stress, air pollution, and crime prevention) is expected that city governments and communities are encouraged to support NbS interventions. **Assessment:** Positive impact (+)
Environmental impacts					
The climate	Critical impact targeted by the strategy. Increase of resilience to climate impacts and preventing climate risks. In addition, potential synergies with mitigation may be worth considering.	Impact on climate resilience (+/-) *(possible) Synergy with climate mitigation*	There is growing scientific evidence that NbS offer multiple benefits for climate change adaptation and disaster risk reduction in particular for sectors that depend on ecosystems and natural resources (e.g. water), such as forestry and agriculture; in urban areas, NbS are effective in providing benefits for adaptation and disaster risk reduction	Targeted direct impact.	The measure will increase the deployment of NbS and is expected to motivate cities and communities to sign up to more ambitions 2030 targets, and to support the implementation of other NbS-related strategies at the EU level, such as the EU Biodiversity Strategy. The climate impact of the measure is expected to influence both climate adaptation and mitigation in Europe. **Assessment:** Positive impact (++)

[258] Faivre, Nicolas, et al. "Nature-Based Solutions in the EU: Innovating with nature to address social, economic and environmental challenges." Environmental research 159 (2017): 509-518.
[259] European Commission (2020) Nature-based solutions towards sustainable communities
[260] European Commission (2020) Nature-based solutions for microclimate regulation and air quality
[261] Shepley, Mardelle, et al. "The impact of green space on violent crime in urban environments: An evidence synthesis." International journal of environmental research and public health 16.24 (2019): 5119.

		(+/-)	(e.g. reducing damage from heavy precipitation and flooding, alleviating impacts of droughts and heat-related challenges)[262] Moreover, NBS can contribute to climate mitigation through both storing and sequestering carbon and reducing energy demand (e.g. by improving thermal comfort cities and promoting the use of walking and cycling routes).[263]		
Quality of natural resources/fighting pollution (water, soil, air, etc.)	Strategy intends to address impacts of climate change on natural resources, e.g. forests, agriculture, marine environment.	Impact on natural resource resilience (+/-)	NbS interventions such as green roofs can achieve cost-effective reductions in drainage systems, whilst improving urban environmental quality, decreasing nutrient and chemical pollution level[264] Moreover, a number of studies, such as the BRIDGE project, have evidenced the NBS's contribution to removing air pollutants such as O_3, $PM_{2.5}$, NO_X, and SO_2.[265]	Targeted direct impact.	The quality of natural resources (including soil, water, and air) will be positively impacted by the increased adoption of NbS, which will be mainly achieved through prioritising and mainstreaming NbS for climate adaptation at local level. **Assessment:** Positive impact (+)
Biodiversity, including flora, fauna, ecosystems and the services they provide, and landscapes	Strategy intends to address impacts of climate change on biodiversity, and to make use of Ecosystem-based solutions.	Use of ecosystem-based solutions and increased resilience of ecosystems	Several EU-funded projects have identified types of NbS that have offer particularly high benefits for biodiversity. Examples of relevant NBS include renaturing landfill sites, brownfields and river corridors, restoration of catchments and coastal	Targeted direct impact.	The measure is expected to increase the attractiveness and thus deployment of NbS. Based on the identified benefits of NbS, the EU biodiversity will be positively impacted as more NbS interventions are supported. **Assessment:** Positive impact (+)

[262]EEA (forthcoming) Nature-based solutions and ecosystem-based approaches to climate change adaptation and DRR in Europe
[263] European Commission (forthcoming) Nature-based solutions- State of the art in the EU-Funded projects.
[264] European Commission (2020) Nature-based solutions improving water quality and waterbody conditions
[265] European Commission (2020) Nature-based solutions for microclimate regulation and air quality

		(+/-)	landscapes, arboreal interventions, and pollinator sites.[266]		
Impacts in developing countries	As highlighted above impacts in developing countries are important to the EU economically (supply chains / markets) and socially (family ties, migration, security). Strategy aims to support improved climate resilience of 3rd (not only developing) countries.	Impact on third countries and international relations (+/-)	NbS are becoming increasingly important in international agreements and policy frameworks,[267] including the UN Framework Convention on Climate Change and the Convention on Biological Diversity. To support the impact of NBS implementation in third countries, the EU has established different programs such as the *Strengthening international cooperation on sustainable urbanisation: nature-based solutions for restoration and rehabilitation of urban ecosystems.*[268] Specific NBS sector dialogues have also been conducted with successful results, such as the EU – Brazil Sector Dialogue on nature-based solutions.[269]	Indirect impact	Particular measures taken to promote global mainstreaming of NBS include Sector Dialogues, which intend to capitalise upon existing experiences and good practices in Europe and beyond. In accordance, this measure is expected to have an indirect impact in developing countries, as knowledge and experience exchange is incentivised.

Some key reports in the field

- EEA (forthcoming 2021) Nature-based solutions and ecosystem-based approaches to climate change adaptation and DRR in Europe
- 2020 IUCN Global Standard for Nature-based Solutions first edition
- European Commission (2020) Nature-based solutions for flood mitigation and coastal resilience
- European Commission (2020) Nature-based solutions improving water quality and waterbody conditions

[266] European Commission (2020) Biodiversity and Nature-based Solutions
[267] European Commission (forthcoming) Nature-based solutions- State of the art in the EU-Funded projects.
[268] See: https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/sc5-13-2018-2019
[269] European Commission (2019) The EU – Brazil Sector Dialogue on nature-based solutions. Available at: https://oppla.eu/sites/default/files/docs/EU-Brazil-NBS-dialogue-1610.pdf

- European Commission (2020) Nature-based solutions for microclimate regulation and air quality
- European Commission (2020) Nature-based solutions towards sustainable communities
- European Commission (2020) Nature-based solutions for climate mitigation
- European Commission (2020) Biodiversity and Nature-based Solutions
- Droste, N. et. al (2017). Implementing nature-based solutions in urban areas: financing and governance aspects. In Nature-based solutions to climate change adaptation in urban areas (pp. 307-321). Springer, Cham.
- van Ham, C., & Klimmek, H. (2017). Partnerships for nature-based solutions in urban areas–showcasing successful examples. In Nature-Based Solutions to Climate Change Adaptation in Urban Areas (pp. 275-289). Springer, Cham.
- ILO (2018) "The employment impact of climate change adaptation". Input Document for the G20 Climate Sustainability Working Group International Labour Office – Geneva
- European Commission (forthcoming) Nature-based solutions- State of the art in the EU-Funded projects
- Relevant platform on NBS https://climate-adapt.eea.europa.eu/eu-adaptation-policy/sector-policies/ecosystem

Horizon 2020 funded projects related to NbS	
RESCUE	River flood Embankments Subject to Climate change: Understanding Effects of future floods and novel 'low-carbon' adaptation measures
DIVERSIFOOD	Embedding crop diversity and networking for local high quality food systems
PEGASUS	Public Ecosystem Goods And Services from land management - Unlocking the Synergies
Ecopotential	IMPROVING FUTURE ECOSYSTEM BENEFITS THROUGH EARTH OBSERVATIONS
ESMERALDA	Enhancing ecoSysteM sERvices mApping for poLicy and Decision mAking
GREEN-WIN	Green growth and win-win strategies for sustainable climate action
TransRisk	Transitions pathways and risk analysis for climate change mitigation and adaption strategies
Aquacross	Knowledge, Assessment, and Management for AQUAtic Biodiversity and Ecosystem Services aCROSS EU policies

INSPIRATION	INtegrated Spatial PlannIng, land use and soil management Research ActTION
BiodivERsA3	Consolidating the European Research Area on biodiversity and ecosystem services
Placard	PLAtform for Climate Adaptation and Risk reDuction
RESIN	Climate Resilient Cities and Infrastructures
SMR	Smart Mature Resilience
INNOVCITIES	Institutional Innovation for Adapting to Climate Change in Water Governance within Cities
OPTWET	Finding optimal size and location for wetland restoration sites for best nutrient removal performance using spatial analysis and modelling
BlueHealth	Linking Up Environment, Health and Climate for Inter-sector Health Promotion and Disease Prevention in a Rapidly Changing Environment
INHERIT	INter-sectoral Health Environment Research for InnovaTions
Sim4Nexus	Sustainable Integrated Management FOR the NEXUS of water-land-food-energy-climate for a resource-efficient Europe
INCOVER	Innovative Eco-Technologies for Resource Recovery from Wastewater
Aquanes	Demonstrating synergies in combined natural and engineered processes for water treatment systems
MERCES	Marine Ecosystem Restoration in Changing European Seas
AMBER	Adaptive Management of Barriers in European Rivers
BRIGAID	BRIdges the GAp for Innovations in Disaster resilience
FOODEV	Food and Gastronomy as leverage for local development
SustUrbanFoods	Integrated sustainability assessment of social and technological innovations towards urban food systems
BioCarbon	Rapid tree-planting through the use of remote sensing and unmanned vehicle planting technologies for large scale reforestation
UNALAB	Urban Nature Labs
CONNECTING nature	COproductioN with NaturE for City Transitioning, INnovation and Governance
NATURVATION	Nature Based Urban Innovation
EN-SUGI	Eranet Sustainable Urbanisation Global Initiative

GROW GREEN	Green Cities for Climate and Water Resilience, Sustainable Economic Growth, Healthy Citizens and Environments
Think Nature	Development of a multi-stakeholder dialogue platform and Think tank to promote innovation with Nature based solutions
Clarity	Integrated Climate Adaptation Service Tools for Improving Resilience Measure Efficiency
UrbanGreenUp	New Strategy for Re-Naturing Cities through Nature-Based Solutions
Nature4Cities	Nature Based Solutions for re-naturing cities: knowledge diffusion and decision support platform through new collaborative models
NAIAD	NAture Insurance value: Assessment and Demonstration
ProGIReg	productive Green Infrastructure for post-industrial urban regeneration
CLEVER Cities	Co-designing Locally tailored Ecological solutions for Value added, socially inclusivE Regeneration in Cities
EdiCitNet	Edible Cities Network Integrating Edible City Solutions for social resilient and sustainably productive cities
Phusicos	'According to nature' - solutions to reduce risk in mountain landscapes
URBiNAT	Healthy corridors as drivers of social housing neighbourhoods for the co-creation of social, environmental and marketable NBS
Operandum	OPEn-air laboRAtories for Nature baseD solUtions to Manage environmental risks
Reconect	Regenarating ECOsystems with Nature-based solutions for hydro-meteorological risk rEduCTion
ReNature	promoting Research Excellence in NAture-based soluTions for innovation, sUstainable economic GRowth and human wEll-being in Malta
EU-VNP-Net	EU Valuing Nature Programme and Network
CLEARING HOUSE	Collaborative Learning in Research, Information-sharing and Governance on How Urban tree-based solutions support Sino-European urban futures

ACTION 5: Stepping-up efforts to build resilience in cities and empower local action.

MEASURE 5.4: Launch a climate adaptation Policy Support Facility / Technical Assistance project supporting local climate adaptation action through the Covenant of Mayors

Baseline, context and rationale

2020 is a crucial year for local climate action, not only due to the Green Deal and the need to ensure a green recovery from COVID-19, but also as it marks the first major milestone for initiatives such as the EU Covenant of Mayors (EU CoM). Founded in 2008, the EU Covenant of Mayors (CoM) is today a well-established initiative. Since its start, it has undergone a series of developments, including the incorporation of climate adaptation and the 2016 formation of the Global Covenant of Mayors. Through the initiative, cities are setting ambitious climate targets, including a commitment to adapt to climate change and reduce greenhouse gas emissions by at least 40% by 2030.[270] The Covenant is also working closely with the European Commission to support and ensure its compatibility with other upcoming EU initiatives such as the European Climate Pact.

The initiative has grown year-on-year since its beginning, and the progress of the initiative today features as one of the key indicators used to track the EU's progress on Sustainable Development Goal (SDG) 13.[271] With 9,654 signatories registered in the EU27 as of June 2020, the initiative encompasses more than 186 million people, or 42% of the EU population. 88% of the signatories are considered to be actively participating in the initiative today, but only 26% of the signatories have so far signed up to the more ambitious 2030 targets. Failing in this transition would jeopardise the initiative, weaken the Commission's ties with local authorities, and hamper progress on the EU's energy and climate targets.

With respect to policy implications, research has shown that in particular smaller and economically weaker European cities and towns, as well as those at high risk from future climate change, need support to engage in adaptation. A dedicated climate network for those highly vulnerable and potentially highly impacted e.g. coastal local authorities might be very useful. This is also supported by conclusions from the recent EEA report on cities and adaptation[272].

[270] The Commission services are currently in a dialogue with the EU Covenant of Mayors Office on how the Covenant's can be updated to reflect the EU's long-term ambitions and potentially revised 2030 targets.
[271] Eurostat, 2020 – Sustainable Development in the European Union: Monitoring report on progress towards the SDGs in an EU context, https://ec.europa.eu/eurostat/web/products-statistical-books/-/KS-02-20-202
[272] https://www.eea.europa.eu/publications/urban-adaptation-in-europe

Description of measure

The 3-year technical assistance project on climate adaptation would be implemented to provide support for some 200 cities/local authorities in Europe. The primary goal of this project is to assist EU cities to catalyse their action on adaptation, and in turn, reduce the vulnerability of Europeans to the impacts of climate change. Through its focus on small and medium-sized cities with lower capacities, the project will target the cities in greatest need and support the Commission's goal of ensuring no one is left behind in the transition to a more sustainable Europe.

The technical assistance will be facilitated in three ways: remote/virtual and on-site technical assistance, and mutual learning webinars and workshops. First, the remote technical assistance will be provided supporting their work on climate adaptation, and including the development and implementation of their Sustainable Energy and Climate Action Plans (SECAPs). Second, the missions will consist on a 2-day visit to the selected cities by a technical expert, who will work on the ground with the city officials to underpin and support the remote assistance. Finally, the mutual learning webinars and workshops will be conducted to complement and further support the technical assistance and promote knowledge exchange among cities at the EU level and internationally.

Objectives and actions:

- Provide tailor-made assistance to EU cities over a period of 3 years to catalyse their action on adaptation, and in turn, reduce the vulnerability of Europeans to the impacts of climate change.
- Assist climate adaptation in vulnerable, small and medium-sized cities (e.g. fewer than 150,000 inhabitants) with limited capacity to adapt to the impacts of climate change.
- Support EU cities in identifying adaptation actions, moving from planning to implementation, and beyond guidance (i.e. capacity building).
- Increase the political visibility and attractiveness of the EU CoM as the key flagship initiative for local climate action in the EU as well as globally, incentivising cities for joining the initiative and signing up to the 2030 targets.
- Facilitate access and knowledge on tools to enable cities to independently continue their work on climate adaptation, increase their adaptive capacity, and eventually become leaders on adaptation in their regions, who disseminate their knowledge to other cities that face similar challenges.
- Establish the baseline to consider the establishment of a stand-alone climate adaptation support facility.

Cost

The project would be delivered through assistance provided by consultants or technical experts. For example, this would be done through an amendment of the existing Covenant of Mayors contract, and the EU Covenant of Mayors Office subcontracting the technical assistance services. The overall budget for the project is estimated to a total of ~**EUR 1,5M**.

Impact pathways

In the table below impacts are assessed using a scale from (--/-/0/+/++) negative to positive. Impacts are assessed up to 2050 relative to the baseline. It assumes the full uptake of the measure as the increasing severity of physical climate risks is more widely recognized in cities, and consequently the relevance for the provision of tailored support to cities.

Table 31: Mini-assessment of Policy Support Facility / Technical Assistance project

Impact indicator	Relevance	Indicator	Baseline	Impact pathway	Envisaged impact 2050 (relative to baseline)
Economic					
Macroeconomic environment	Impacts on the economy are a hugely significant driver for action and reducing damages can be an important indicator of increased resilience.	Economic welfare (losses) (-/+)	Losses to productivity from absences due to effects of climate change in cities. The CoM signatories are encouraged to evaluate and report impacts on socio-economic sectors of climate change. The baseline would be based on the contributions by the top 10 cities to GVA.	Indirect impact – economic benefits of reduced productivity losses from climate adaptation action in cities prompted by the technical assistance project.	Impacts included in modelling results in chapter 6. This measure is interpreted as reducing the heat stress in urban areas, largely through green infrastructure and climate resilient adapted buildings. The direct measure is to launch climate adaptation policy support facility and/or a technical assistance project. Assuming such a facility will improve investment in adaptation, we modelled investment in cities. We assumed this leading to increased resilience and a damage reduction of 1% of the productivity losses from heat waves (Orlov et al. (2019)) for the RCP2.6 scenario, 5% reduction under the warmer RCP4.5 scenario and a 10% less productivity loss under the 4°C scenario. These values are based on own assumptions. The productivity losses from heat in the reference case are modelled to match (Orlov et al. (2019)). They range from 0.7% in the North to 2.8% in the southern Member states. The spread over different warming scenarios is taken from Orlov, the distribution over European regions stems from the distribution of fatalities across Europe in Szewczyk (2020). The investment goes mostly into additional demand for construction. The amounts are taken from Lehr et al. (2020) and are rescaled for the Member States proportional to the population. **Assessment:** Quantitative results included in chapter 6, qualitative

					assessment, (0/+)
Competitiveness, trade and investment flows	Vulnerability of supply chains to impacts can be relevant and The Strategy will significantly influence the types of investments being made.	Impact on competitiveness, trade and (climate resilient) investments (+/-)	Minimal impact	Minimal impact	
Regulatory burden on business	Support provided to public authorities unlikely to have significant effect on businesses.	Regulatory burden on business (+/-)	Minimal impact	Minimal impact	
Increased innovation and research	The Strategy will guide research under Horizon Europe and aims to encourage greater adoption of innovation.	Impact on adaptation innovation adoption (+/-)	The CoM Awards call is one of the opportunities encouraging the CoM signatories to innovate in their climate adaptation planning (particularly in financial instruments). It awards three signatories: 1 small-sized signatory (<10,000 inhabitants) 1 medium-sized signatory (10,000- 250,000 inhabitants) 1 large-sized signatory (>250,000 inhabitants)	Targeted direct impact	The Technical Assistance project' impact on innovation is expected to be high, as it will foster the exchange between different communities and cities and stimulate demand for adaptation services and innovation. The impact could be evaluated based on the number of CoM cities participating in initiatives that recognise innovative adaptation planning. **Assessment:** Positive impact (+)
Public authorities (and budgets)	The Strategy will significantly impact on public spending on climate resilience, primarily through indirect routes.	Public spending on adaptation (€)	The total public spending as a percentage of public spending on climate adaptation and resilience as a percentage of the city's GDP (GDPc). (Goergeson L. et al, 2016) can help provide baseline: Between 0.14 and 0.33% GDPc was allocated by cities globally in climate adaptation. 0.22% GDPc was spent by the city of Paris on adaptation and resilience in 2014/2015. growth of the spending between 2008-2015 was 4.03% [273]	Targeted direct impact	Since the Technical Assistance project will increase the attractiveness of the CoM and motivate cities to sign up to more ambitions 2030 targets, it is expected that the **percentage of public spending** on climate adaptation measures will increase in the selected cities. **Assessment:** Positive (+),

[273] Georgeson, L. et al (2016) "Adaptation responses to climate change differ between global megacities" Nature Climate Change 6.6 (2016): 584-588.

			Moreover, according to the 2019 CoM assessment[274], 700 million EUR have been allocated to adaptation by CoM signatories.		
Social impacts					
Employment	Impacts on the economy and in-turn on employment are a hugely significant driver for action and reducing damages and job losses can be an important indicator of increased resilience.	Employment (FTE)	Adaptation measures can lead to employment gains and prevent job losses. Evidence suggests that in Europe around 500,000 additional jobs will be directly and indirectly created by 2050 as a result of the increase in adaptation-related activities.[275] Today, in Germany 6 % of total employment relies directly on ecosystem services; while in the European Union (EU) as a whole the proportion is as high as 16 %.[276]	Targeted direct impact	Skills development is a core component of the Technical Assistant project. Capacity-building activities increase the adaptive capacity of a city because it helps displaced workers to move on to sectors where there is employment growth, thus protecting them against income losses and other adverse effects of climate change. A shortage of skills would in any case be an obstacle to the implementation of adaptation measures.[277] The **number of participants** on the capacity building activities related to skills development on climate adaptation of the Technical Assistant project will provide an indication of the impact of initiative on the resilience of the employment in the selected cities. **Assessment:** Positive impact (+)
Income distribution, social protection and social inclusion (of particular groups)	Distributional impacts of climate change can be significant, the Strategy is intended to address and mitigate inequalities, including through better informing citizens and encouraging action. Needs to address broader questions of equity (see other impacts) such as location, economic and social cohesion, gender and of fundamental rights.	Distributional and equity impacts (+/-)	Based on the 2019 CoM assessment[278]: Most of the Covenant of Mayors signatories (90 %) are small- and medium-sized towns, which are in more need of support due to limited financial and human resources. Regarding the participation across different EU countries, the CoM still plays a very different role in each country. The large majority of CoM signatories reporting adaptation goals (82%) are from Italy, Spain and Belgium. In addition, the percentage of the CoM	Indirect impact	The Technical Assistance project aims to primarily support small and medium-sized cities, which are most vulnerable to climate change. However, it has been reported that the proportion of cities with an autonomous and comprehensive adaptation plan increases in line with their size[279], which suggests that small cities are more likely to lack adaptation strategies in place. **Assessment:** Positive impact (+)
				Targeted direct impact	The impact of the Technical Assistance project on social inclusion is expected to be reflected in: - percentage of population covered by CoM signatures per country. - percentage of CoM signatories reporting vulnerabilities that are small- and

[274] Bertoldi, P et. Al (2020), "Covenant of Mayors: 2019 Assessment", Publications Office of the European Union, Luxembourg" ISBN 978-92-76-10722-4, doi:10.2760/775755, JRC118927
[275] Triple E Consulting. (2014). "Assessing the implications of climate change adaptation on employment in the EU: Final report and annexes"
[276] ILO (2018) "The employment impact of climate change adaptation". Input Document for the G20 Climate Sustainability Working Group International Labour Office – Geneva,
[277] Ibid.
[278] Bertoldi, P et. Al (2020), "Covenant of Mayors: 2019 Assessment", Publications Office of the European Union, Luxembourg" ISBN 978-92-76-10722-4, doi:10.2760/775755, JRC118927
[279] Reckien, D. et al. (2018). How are cities planning to respond to climate change? Assessment of local climate plans from 885 cities in the EU-28. Journal of Cleaner Production. 191. 207-219. 10.1016/j.jclepro.2018.03.220.

			signatories reporting vulnerabilities is low (36-42%), despite vulnerabilities are a key dimension for the climate risk assessment. Moreover, as a baseline, public participation in adaptation planning is to be used, as it makes urban adaptation more equitable and ensures the inclusion of the views of the most vulnerable communities. Nonetheless, today only 43-44% of the signatories of the CoM report to have involved stakeholders and citizens in climate adaptation planning.		medium-sized. - percentage of CoM signatories reporting socio-demographic vulnerabilities - the average percentage of CoM signatories reporting stakeholders and citizens engagement in climate adaptation planning. The project will encourage stakeholder participation throughout the adaptation policy cycle. **Assessment:** Positive impact (++)
Public health & safety and health systems	Increased resilience of public health and safety systems is an important goal of the Strategy.	Impact on public health and civil emergency systems (+/-)	According to the 2019 CoM Assessment, CoM signatories have reported +310 actions (including ongoing completed, not started) on the health sector, and +320 on civil protection and emergency in their climate adaptation strategies.	Indirect impact	The Technical Assistance project will increase the attractiveness of the CoM. It is expected that, from the start, the Technical Assistance project will motivate several cities to adhere to CoM. Therefore, the **number of completed actions** for the health and civil protection and emergency sectors reported by the CoM signatories after the launch of the Technical Assistance Project will provide evidence of the impact of the initiative on the health and safety services of the cities. **Assessment:** Positive impact (+)
Environmental impacts					
The climate	Critical impact targeted by the strategy. Increase of resilience to climate impacts and preventing climate risks. In addition, potential synergies with mitigation may be worth considering.	Impact on climate resilience (+/-) *(possible) Synergy with climate mitigation (+/-)*	CoM membership is currently one of the most influential and significant drivers of adaptation, to the extent that the capacity of a city to engage in climate actions is a more important driver of adaptation planning than anticipated impacts and anticipated vulnerability[280]. According to the 2019 CoM, 429 signatories out of 2221 (370 from EU28+EFTA and 59	Targeted direct impact.	The technical assistance will increase the attractiveness of the CoM and motivate cities to sign up to more ambitions 2030 targets. Therefore, the **number reported adaptation goals and implemented actions** by the CoM signatories after the launch of the Technical Assistance Project would provide evidence of the impact of the initiative on the climate. **Assessment:** Positive impact (++)

[280] Reckien, D. et al (2015) "The influence of drivers and barriers on urban adaptation and mitigation plans—an empirical analysis of European cities." PloS one 10.8 (2015): e0135597.

			non-EU28+EFTA) have already provided information regarding their adaptation goals, risk and vulnerability assessments or action plans.		
Quality of natural resources/fighting pollution (water, soil, air etc.)	Strategy intends to address impacts of climate change on natural resources, e.g. forests, agriculture, marine environment.	Impact on natural resource resilience (+/-)	Some of the CoM signatories especially in EU28+EFTA municipalities have already completed the implementation of adaptation actions and reported the associated impacts on the environment. Concretely, the majority of actions (ca. 600), including all completed, on-going and planned actions, are reported to have an impact on the water sector. On air quality, the data reported by Monforti-Ferrario, F. et al (2018) [281] on Air Quality Benefit (AQB) different kinds of SEAP measures proposed by 146 CoM cities could be explored to be used as a baseline.	Indirect impact	The Technical Assistance project will increase the attractiveness of the CoM. It is expected that, from the start, the Technical Assistance project will motivate several cities to sign up to CoM. Once part of the coalition, the city will commit to set up climate adaptation targets through the development of the SECAP. On this, the Guidebook for CoM signatories developed by the JRC includes water as a key vulnerable sector to evaluate. Therefore, the **number of completed actions** for the water reported by the CoM signatories after the launch of the Technical Assistance Project will provide evidence of the impact of the initiative on the quality and natural resources of the cities. If data is available, the **change of the AQB** in time will also provide evidence of the impact on resource quality in CoM cities. **Assessment:** Positive impact (+)
Biodiversity, including flora, fauna, ecosystems and the services they provide and landscapes	Strategy intends to address impacts of climate change on biodiversity, and to make use of Ecosystem-based solutions.	Use of ecosystem-based solutions and increased resilience of ecosystems (+/-)	According to the 2019 CoM Assessment, CoM signatories have reported +270 actions (including ongoing completed, not started) on the biodiversity and environment sector, +320 on land-use planning, +290 on agriculture and forestry.	Indirect impact	The Technical Assistance project will increase the attractiveness of the CoM. It is expected that, from the start, the Technical Assistance project will motivate several cities to sign up to CoM. Once part of the coalition, the city will commit to set up climate adaptation targets through the development of the SECAP. On this, the Guidebook for CoM signatories developed by the JRC includes biodiversity and environment, land-use planning, and agriculture and forestry, as key vulnerable sectors to evaluate. Therefore, the **number of completed actions** for the above-mentioned sectors reported by the CoM signatories after the launch of the Technical Assistance Project will provide evidence of the impact of the initiative on the biodiversity of the cities. **Assessment:** Positive impact (+)

[281] Monforti-Ferrario, F. et al (2018) "The impact on air quality of energy saving measures in the major cities signatories of the Covenant of Mayors initiative." Environment international 118 (2018): 222-234.

Cross cutting impacts					
Impacts in developing countries	As highlighted above impacts in developing countries are important to EU economically (supply chains / markets) and socially (family ties, migration, security). Strategy aims to support improved climate resilience of 3rd (not only developing) countries.	Impact on third countries and international relations (+/-)	In total, up to November 2019, 2 221 municipalities have become signatories of the Global Covenant of Mayors and reported through MyCovenant platform, that includes providing information on adaptation. From these total number of signatories, 1 922 belong to EU28+EFTA countries and 299 to non-(EU28+EFTA). Further, the number of non-EU cities taking part of the outreach activities of the CoM could be used as a baseline.	Indirect impact	Although the recipients for the Technical Assistance project would be participants in the EU Covenant of Mayors, the project will **include mutual learning webinars and workshops that could be open to participation of cities outside Europe as well**. This will allow EU cities to share their experiences, lessons learned and good practices with non-EU countries and thus, further promote the adoption of climate adaption plans globally. Moreover, the output of the Technical Assistance project, including relevant data, risk assessments and adaptation plans would be **made publicly available** and disseminated, through platforms such as Climate-Adapt and the EU CoM website. This will enable non-EU cities to make use of the acquired knowledge to develop their own adaptive capacity. Finally, the project would also **increase the political visibility** and attractiveness of the EU CoM as the key flagship initiative not only for local climate action in the EU but also globally. **Assessment:** Positive impact (+)

Some key reports in the field

- EEA (2020) Urban Adaption in Europe https://www.eea.europa.eu/publications/urban-adaptation-in-europe
- Reckien, D. et al (2015) "The influence of drivers and barriers on urban adaptation and mitigation plans—an empirical analysis of European cities."
- Monforti-Ferrario, F. et al (2018) "The impact on air quality of energy saving measures in the major cities signatories of the Covenant of Mayors initiative.
- Bertoldi, P et. Al (2020), "Covenant of Mayors: 2019 Assessment", Publications Office of the European Union, Luxembourg" ISBN 978-92-76-10722-4, doi:10.2760/775755, JRC118927
- Reckien, D. et al. (2018). How are cities planning to respond to climate change? Assessment of local climate plans from 885 cities in the EU-28. Journal of Cleaner Production.

MEASURE 5.6: Support vulnerable groups and enterprises through education and reskilling initiatives for green jobs and new business models, including through the European Skills Agenda and European Social Fund Plus (ESF+), with a particular focus on adaptation and resilience.

Baseline, context and rationale

The **Multiannual Financial Framework** (**MFF**) serves as the basis for the implementation of the EU budget and allows the European Commission and Member States to implement EU policies and deliver the objectives of the EU mission, such as those to support vulnerable groups and enterprises. The MFF covers seven areas of funding, of which over half is channelled through the 5 European Structural and Investment Funds (ESIF)[282]. The **European Social Fund (ESF)** is one such channel, and aims at enhancing employment and fairer life opportunities for all. It is the EU's main tool for helping people find employment (or better employment), integrate disadvantaged people into society, and ensure fairer life opportunities for all. The **European Social Fund Plus (ESF+)** is the successor of the ESF under the newest MFF budget period. The governance for the ESF+ and the other ESIF funds is laid out in the **Common Provisions Regulation (CPR)**. In the next budget period, these funds will be managed by a new CPR. The new CPR builds off the current one and introduces a number of innovations, such as:

- a smarter Europe, through innovation, digitisation, economic transformation and support for small and medium-sized businesses;
- a greener, carbon free Europe, implementing the Paris Agreement and investing in energy transition, renewables and the fight against climate change;
- a more connected Europe, with strategic transport and digital networks;
- a more Social Europe, delivering on the European Pillar of Social Rights and supporting quality employment, education, skills, social inclusion and equal access to healthcare;
- a Europe closer to citizens, by supporting locally led development strategies and sustainable urban development across the EU.

Of these, the ESF+ will contribute the Social Europe policy pillar. From the proposal for the ESF+ regulation, it is clear that the rules and guidelines for climate action within the Fund are still under development[283]. The regulation mentions that the contribution of the ESF+ to the 30% target of the

[282] European Commission (2018). European structural and investment funds.
Retrieved from: https://ec.europa.eu/info/funding-tenders/funding-opportunities/funding-programmes/overview-fundingprogrammes/european-structural-and-investment-funds_en#thefunds
[283] European Commission (2018). Proposal for a regulation of the European Parliament and of the Council on the European Social Fund Plus (ESF+), COM (2018) 382 final, 30.5.2018.

MFF will be tracked through an EU climate marker system at an appropriate level of disaggregation, including the use of more precise methodologies where these are available. Climate change will affect labour markets through impacts from regulations affecting supply and demand side employment, as well as direct impacts on natural and built environments[284]. According to the most recent PESETA III report[285], the total EU welfare loss due to climate change under a high warming scenario is estimated to be around 1.9% of GDP (EUR 240 billion) per year by the end of the century. This is mostly associated to heat-related mortality, coastal and river flooding, decrease in labour productivity, and agriculture losses. Welfare losses are further vulnerable to changes in trade flows associated with climate change which could increase losses by another 20%. A previous study by Trinomics[286] estimated that potential job losses around 410,000 by 2050 if no adaptation measures are taken. On the other end of the spectrum, the study estimated that adaptation measures could lead to the creation of 500,000 jobs by 2050. Three sectors, water management, energy supply, and transport infrastructure, are likely to see the largest investments in Europe's adaptation to climate change, and thus the largest net employment gains[287]. Together these sectors account for 90% of employment gains associated with adaptation investments.

The question of what constitutes green skills and jobs is difficult to answer. Primarily because each Member State approaches reskilling employees for the green economy differently, with no common approach to data collection or definition for green jobs. This means that methods for categorising and measuring the amount of green jobs varies among countries. Despite these differences in classifications and methods, changes in green employment are largely contributed to two factors: 1) the general economic cycle, and trends in government policy and the availability of governmental incentives and subsides. Permanent mechanisms dedicated to the green economy and green employment, including green skills anticipation, are needed but rather rare in the EU. The **European Skills Agenda**, a five-year plan to assist skill building for individuals and businesses is one such foray. It enshrines social fairness, such as access to education, training and lifelong learning, and seeks to strengthen sustainable competitiveness and build resilience to crises. The European Skills Agenda also seeks to unlock investments (both public and private) in skills.

Interviews: In the interviews, social impact of the Strategy was mentioned by several interviewees. One interviewee felt that the biggest added value for analysis on adaptation is with a focus on the economic case. Where the economic impact is being regarded as the enabler of environmental and social action. They further specified that social impact, which is closely related to the economic impact, should focus on well-being, job security, and

[284] Martinez-Fernandez, C., Hinojosa, C., & Miranda, G. (2010). Greening jobs and skills labor market implications of addressing climate change oecd.
[285] Ciscar J.C., Feyen L., Ibarreta D., Soria A. (2018), Climate impacts in Europe, Final report of the JRC PESETA III project, https://ec.europa.eu/jrc/en/news/climate-change-human-and-economic-outlook-europeans
[286] Trinomics (formerly: Triple E consulting) (2014), Assessing the implications of climate change adaptation on employment in the EU, available at: https://climate-adapt.eea.europa.eu/metadata/publications/assessing-the-implications-of-climate-change-adataptation-on-employment-in-the-eu-1
[287] Görlach, B., Thie, JE., Faber, R., Stenning, J., Lonsdale, J. (2020) Employment policies to support a low-carbon and climate resilient transition
Draft Final Report - Adaptation component.

health. Another interviewee discussed the overall resistance to some of the big changes that need to happen for jobs, i.e. moving people from one sector to another. They felt that the EU needs to focus on vulnerable sectors and people.

OPC: Question 12 of the OPC asked respondents how important it is for a new EU Adaptation to achieve improved health, social cohesion and resilience. The majority of respondents felt it was very important (58%).

ACTION 6: Further mainstreaming and integrating adaptation in EU legislation and instruments

NO MEASURE selected on Action 6

ACTION 7: Climate Proofing of Infrastructure and beyond.

7.2: Ensure climate-proofing guidelines are applied as widely as possible for the climate resilience of new infrastructures in Europe and abroad.

Baseline, context, and rationale

The 2013 Strategy through Action 7 led to the development of guidelines and technical standards for climate proofing in the infrastructure sector[288]. The 2018 Evaluation concluded that there remains room for improvement in the awareness and actual use of these guidance documents for project managers. The provision of guidance documentation on how to use methodologies or develop the required infrastructure project documentation relating to climate adaptation is crucial for the effective implementation of adaptation measures.[289]

[288] European Commission (2016). Non-paper Guidelines for Project Managers: Making vulnerable investments climate resilient.
[289] European Commission (2018). Climate change adaptation of major infrastructure projects. A stock-taking of available resources to assist the development of climate resilient infrastructure. Retrieved from: https://ec.europa.eu/regional_policy/en/information/publications/studies/2018/climate-change-adaptation-of-major-infrastructure-projects

In the transport sector, for instance, incremental climate change effects (e.g., sea-level rise, heat waves) can result in transportation infrastructure damages, operational disruptions, and pressures on supply chain capacity and efficiency[290]. Nonetheless, as the 2018 evaluation concluded, there is still a lack of awareness about the importance of climate proofing in the infrastructural sector and room for improvement in the usage of guidelines and technical standards. This lack of awareness may be one of the causes of the uneven and weak understanding of vulnerabilities and the need to establish climate resilient transport infrastructure across Europe. Therefore, as part of the new EU Adaptation Strategy, planning and climate risk management will be reinforced by e.g. strengthening climate-proofing transport.

When asked in the OPC how respondents would rate a list of potential actions for a new EU Adaptation Strategy, half of the respondents found it very important to increase infrastructure resilience through extended use of EU climate proofing guidance (50 %).In the context of the recovery from the COVID-19 crisis, the importance of application of climate proofing guidelines for the planned Renovation Wave has been reinforced. Consequently, the new Strategy will seek to set up the needed tools and guidance to support the investment in infrastructure that is coherent with the "build back better" approach.

Description of measure

This measure will seek to ensure that the climate proofing guidelines are applied as widely as possible for the climate resilience of new infrastructures in Europe and abroad. Building on the existing guidelines and technical standards developed as part of the 2013 Strategy through Action 7, it will promote the application of the guidelines to address the climate resilience of existing infrastructure, in particular for critical infrastructures (i.e. those essential for the maintenance of vital societal functions, health, safety, security, economic or social well-being of people), and networks (e.g. transport, communication, and energy).

Objectives and actions:

- Understand the reasons behind the low application of the climate proofing guidelines developed as part of the 2013 Strategy through Action 7 to address the climate resilience of existing infrastructure, to ensure that these are improved in accordance to the gaps expressed by the users (e.g. project managers, urban practitioners)

[290] UNECE - United Nations Economic Commission for Europe (2020). Climate Change Impacts and Adaptation for Transport Networks and Nodes. Available at: https://www.unece.org/fileadmin/DAM/trans/doc/2020/wp5/ECE-TRANS-283e.pdf

- Ensure that the climate proofing guidelines are applied as widely as possible for the climate resilience of new infrastructures in Europe and abroad, taking into consideration the latest developments by the European Committee for Standardisation (CEN, Centre Européen de Normalisation) and the International Standards Organisation (ISO), which are constantly reviewing existing standards to better address climate risk. This should be done by e.g. exchanges with operators of critical infrastructures and relevant engineering companies, to assess how these guidelines could complement the current engineering and design requirements, as well as the operation and maintenance practices.
- Disseminate the use of other existing tools to support climate proofing of infrastructure, such as the 'HARmonized grids of Critical Infrastructures in Europe' (HARCI-EU) dataset, which were produced by integrating geospatial and statistical data from multiple sources and provide a consistent mapping of critical infrastructure in key sectors that can serve as exposure information for large-scale risk assessments in Europe; and incorporate the outcome of other EU funded relevant projects such as IMPROVER (Improved risk evaluation and implementation of resilience concepts to critical infrastructure), and EU Circle (a Pan-European framework Strengthening Critical Infrastructure Resilience to Climate Change)
- Build capacity of partner countries to apply climate proofing guidance, e.g. through mechanisms to support climate proofing of investments (similarly to how it is currently done for EU-funded investments in the EU through Structural Funds).

Impact pathways

In the table below impacts are assessed using a scale from (--/-/0/+/++) negative to positive. Impacts are assessed up to 2050 relative to the baseline. It assumes the full uptake of the measure as the increasing severity of physical climate risks results in disruptive impacts across Europe, and consequently the relevance of climate-proofed infrastructure is widely recognised.

Table 32: Mini-Assessment of Climate Proofing of Infrastructure and Disaster Risk Management

Impact indicator	Relevance	Indicator	Baseline	Impact pathway	Envisaged impact 2050 (relative to baseline)
Economic					
Macroeconomic environment	Impacts on the economy are a hugely significant driver for action and reducing damages can	Economic welfare (losses)	A study led by the EU JRC[291] assessed the risks on the economy of damages on critical infrastructure caused by climate change extremes using a prognostic modelling framework. It was found that	Direct impact	Included in modelling results for Option 1 in chapter 6. This measure ensures climate-proofing guidelines are applied as widely as

[291] Forzieri, Giovanni, et al. "Escalating impacts of climate extremes on critical infrastructures in Europe." Global environmental change 48 (2018): 97-107.i

	be an important indicator of (-/+) increased resilience.		the expected annual damage (EAD) of multihazard and -sector impacts of critical infrastructures was €3.4 billion per year for EU+ in 2010 but is projected to amount to approximately €9.3 billion, €19.6 billion, and €37.0 billion per year by the 2020s, 2050s, and 2080s, respectively, only because of the effects of climate change. As a baseline, in 2020 Q1 the GVA of transport of good-related sectors (e.g. NACE wholesale and retail trade, transport, accommodation, and food service activities) in EU27 was €546,557.3 million and of industry (NACE industry) € 600 246 million.[292]		possible for the climate resilience of new infrastructures in Europe. The damages in the tourism and in the transport-sector are reduced by an assumed percentage 10% in the tourism sector and 20% in the transport sector. The narrative behind this would be region specific. The damages in the tourism sector are infrastructure related or mitigatable by improved infrastructure. The reduction of damages from infrastructure is derived from Lehr et al. 2019 estimates for Germany and distributed across Member States according to the damages in the transport sector. **Assessment:** Quantitative results included in Option 1 assessment in Chapter 6, qualitative assessment (+)
Competitiveness, trade, and investment flows	Vulnerability of supply chains to impacts can be relevant and the Strategy will influence the types of investments being made.	Impact on competitiveness, trade and (climate resilient) investments (+/-)	Estimates of annual infrastructure investment needs have ranged from some US$ 3.7 -7 trillion a year, however, available funds are three orders of magnitude smaller and this significantly insufficient.[293]	Indirect impact	By promoting the use of climate proofing methodologies, this measure is expected to have a positive impact on investment flows, as the participation of the private sector is expected to be encouraged. **Assessment: Positive impact (+)**
Regulatory burden on business	Changes to guidance and standards in affected sectors will change the way that firms work. Can require additional actions to meet climate resilient standards.	Regulatory burden on business (+/-)	Financial and insurance sector businesses have some data sharing requirements, but as established processes should not lead to additional costs in the baseline scenario.	Direct impact	Requiring greater provision of data and defining the format and granularity of this data, would impose additional costs on firms that hold and would need to provide this data. Affected firms will be mostly large firms concentrated in the financial sector. **Assessment:** (-)
Increased innovation and research	The Strategy will guide research under Horizon Europe and aims to	Impact on adaptation		Minimal impact	The success of this measure significantly depends on the level of understanding of the

[292] Eurostat. Gross value added and income A*10 industry breakdowns
[293] https://www.tandfonline.com/doi/full/10.1080/24724718.2019.1594567

	encourage greater adoption of innovation.	innovation adoption (+/-)			reasons behind the low application of the climate proofing guidelines developed as part of the 2013 Strategy and on proposing improvement approaches. For this, past (e.g. IMPROVER), current, and future Horizon Europe projects will be very relevant. **Assessment: Positive impact (+)**
Public authorities (and budgets)	The Strategy will significantly impact on public spending on climate resilience, primarily through indirect routes.	Public spending on adaptation (€)	Before the MFF 2021-2027 was released, 20% of the EU budget was spent on climate action explicitly, but there were no 'climate proofing' requirements for the remaining 80% of the budget.[294]	Indirect impact	The new Strategy will ensure climate-proofing guidelines are applied as widely as possible for the climate resilience of new infrastructures. Moreover, it will require climate proofing of all EU external investments (See Measure 11.1) both through grants, guarantees and blending instruments. As a result, the public budget allocated to ensure the climate proofing of new infrastructure is expected to increase. **Assessment: Positive impact (+)**
Social impacts					
Employment	Impacts on the economy and in-turn on employment are a hugely significant driver for action and reducing damages and job losses can be an important indicator of increased resilience.	Employment (FTE)	Investing in climate-resilient infrastructure has a positive impact on employment since it increases the demand for construction sector output. However, in Europe, the effect will be lowered compared to other regions. ILO (2018) [295] presents an estimate of the construction sector employment multiplier for every US$1 million invested in adaptation infrastructure, which can serve as a baseline. In Germany, for every US$1 million invested in the construction sector, it is expected that 15 jobs will be created. The magnitude of the employment impact varies for each infrastructure project.	Indirect positive impact	By promoting the climate proofing of infrastructure and beyond, it is expected that the new strategy will foster the creation of jobs not only related to the implementation of the improved methodologies but in the critical infrastructure related-sectors (construction, transport) because of an increase of better-informed investment flows. **Assessment: Positive impact (+)**
Income distribution, social protection and	Distributional impacts of climate change can be significant, the	Distributional and equity	The effects of climate change in Europe will be uneven across countries, as indicated in the latest PESETA IV report. In the case of	Targeted impact	The rigorous application of climate proofing guidelines for critical infrastructure ensures that

[294] López, Sofia, et al. (2020). Adapting to change: Time for climate resilience and a new adaptation strategy. European Policy Centre. Issue Paper.
[295] ILO (2018) "The employment impact of climate change adaptation". Input Document for the G20 Climate Sustainability Working Group International Labour Office – Geneva,

social inclusion (of particular groups)	Strategy is intended to address and mitigate inequalities, including through better-informing citizens and encouraging action. Needs to address broader questions of equity (see other impacts) such as location, economic and social cohesion, gender and of fundamental rights.	impacts (+/-)	critical infrastructure, some regions will experience higher direct damages. For instance, increased river and coastal flooding could disturb significantly energy infrastructures in flood-prone areas. Similarly, countries that depend largely on maritime transport infrastructure (e.g. coastal zones), will be most severely affected by sea-level rise and coastal extremes.[296]		the adaptive capacity of the most vulnerable regions and sectors to the effects of climate change will be improved. **Assessment: Positive impact (++)**
Public health & safety and health systems	Increased resilience of public health and safety systems is an important goal of the Strategy.	Impact on public health and civil emergency systems (+/-)	A number of actions under the 2013 Adaptation Strategy (such as 'climate proofing' infrastructure projects) did address some climate-related anticipatory and preventive health concerns but not to the extent needed.[297]	Indirect impact	By ensuring the application of climate proofing guidelines for the improvement of the infrastructure of health and other public systems services, the new Strategy will have a positive effect on the prevention of disruption of the services (electricity supply, transport, water supply, etc.). Furthermore, increased asset life, reduced repair and maintenance costs because of climate proofing, is expected to decrease the need for retrofitting and maintenance costs and the risk of the asset becoming prematurely obsolete. **Assessment: Positive impact (++)**
Environmental impacts					
The climate	Critical impact targeted by the strategy. Increase of resilience to climate impacts and preventing climate risks. In addition, potential synergies with	Impact on climate resilience (+/-) *(possible) Synergy with*	Infrastructure networks will be affected by the physical impacts of climate variability and change, but will also play an essential role in building resilience to those impacts, considering that the long-lived nature of infrastructure implies that decisions made now will lock-in vulnerability if they fail to consider these impacts.[298]	Targeted direct impact.	Through promoting the application of climate proofing guidelines for critical infrastructure, this measure will contribute to the achievement of the goals of the Paris Agreement by increasing the capacity to adapt to climate

[296] Feyen L., Ciscar J.C., Gosling S., Ibarreta D., Soria A. (editors) (2020). Climate change impacts and adaptation in Europe. JRC PESETA IV final report. EUR 30180EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-76-18123-1, doi:10.2760/171121, JRC119178.
[297] European Commission (2020) Adaptation to Health Effects of Climate Change in Europe Group of Chief Scientific Advisors. Available at: https://www.kowi.de/en/Portaldata/2/Resources/fp/scientific-opinion-adaptation-to-climate-_change-related-health-effects.pdf
[298] OECD (2018) Climate-resilient Infrastructure – Policy perspectives

	mitigation may be worth considering.	*climate mitigation (+/-)*	Moreover, climate proofing has shown to be very relevant for sectors with high climate mitigation potential, such as energy.[299]		change and confirming that investments are consistent with a low-emissions and climate-resilient development. **Assessment: Positive impact (++)**
Quality of natural resources/fighting pollution (water, soil, air, etc.)	Strategy intends to address impacts of climate change on natural resources, e.g. forests, agriculture, marine environment.	Impact on natural resource resilience (+/-)	The quality and availability of natural resources can be improved by climate proofing infrastructure dependent on these resources. For instance, climate-proofed investments in the hydropower sector can avoid unintended consequences on the availability and quality of water resources.	Indirect impact	This measure aims to encourage climate-proofed investments in some sectors that are highly dependent on the use of natural resources (e.g. energy generation). Therefore, it can be expected that it will have a positive impact on natural resources utilised. **Assessment: Positive impact (+)**
Biodiversity, including flora, fauna, ecosystems and the services they provide and landscapes	Strategy intends to address impacts of climate change on biodiversity, and also to make use of Ecosystem-based solutions.	Use of ecosystem-based solutions and increased resilience of ecosystems (+/-)	Some approaches to climate-resilient infrastructure, particularly the use of natural infrastructure, can lead to biodiversity conservation, such as NbS.[300] Coastal resilience, for example, can be achieved for substantially lower costs through restoration projects in mangroves and salt marshes for wave reduction compared to traditional alternatives such as breakwaters.[301]	Indirect impact	By raising awareness about the multiple benefits of some approaches for climate-resilient infrastructure such as NbS for coastal critical infrastructure, this measure is expected to have a positive impact on biodiversity conservation in the areas where these approaches are considered. **Assessment: Positive impact (+)**

Some key reports in the field

- European Commission (2018) Climate change adaptation of major infrastructure projects- A stock-taking of available resources to assist the development of climate-resilient infrastructure
- OECD (2018) Climate-resilient Infrastructure – Policy perspectives
- OECD (2019) Good Governance for Critical Infrastructure Resilience

[299] Feyen L., Ciscar J.C., Gosling S., Ibarreta D., Soria A. (editors) (2020). Climate change impacts and adaptation in Europe. JRC PESETA IV final report. EUR 30180EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-76-18123-1, doi:10.2760/171121, JRC119178.
[300] OECD (2018) Climate-resilient Infrastructure – Policy perspectives
[301] European Commission (2020) Nature-based solutions for flood mitigation and coastal resilience

- CLARITY – Climate Resilience Project's Documentation. https://clarity-h2020.eu/
- EU-CIRCLE Project's Documentation: (https://www.eu-circle.eu /)
- RESISTO Project's Documentation (http://www.resistoproject.eu/)
- INFRASTRESS Project's Documentation (https://www.infrastress.eu/)

ACTION 8: Narrowing the Climate Protection Gap—Micro-economic policy

MEASURE 8.2: Funding instruments: mainstreaming of resilience, adaptation and climate risk management concerns in the design of calls and of project selection criteria and the identification of "EU interest" resilience upgrades required for interconnected critical infrastructure

MEASURE 8.3: EU policy settings influencing private finance. Focus on the importance of adaptation ambition in the revision of the Non-Financial Reporting Directive and of prudential rules.

Baseline, context and rationale

Given the unavoidable rise of climate pressures in the years ahead, the EU and its Member States need to review their financial preparedness to deal with adverse climate impacts and to consider actions to make societies more resilient. **Climate-driven events pose risks to assets and economic activities**. As losses occur, households, firms and governments are affected. Fiscal sustainability and financial stability implications may arise as extreme climate related events by their very nature tend to affect many economic actors at the same time, including critical interconnected infrastructure, goods and services such as energy, transport, ICT, water and food supplies. The extent to which the adverse effects from the materialisation of such risks affect the real economy depend to an important extent on resilience, risk preparedness and business continuity approaches, but also on how losses are ultimately allocated, and the extent to which they are covered/anticipated including by risk pooling instruments, both nationally and across borders.

It is important to consider that **not all environments, activities, assets and people are affected in the same way**. Impacts can therefore only be understood, measured, reduced and managed in a local and sectoral context. This calls for a multi-sectoral and cross-cutting approach to mainstreaming climate-related financial risk management into policy design and decision-making at EU level.

The **climate protection gap** has been defined as the difference between the insured losses and the total economic losses caused by an extreme weather or climate-related event. Overall, only an estimated 35% of the total losses caused by climate extremes across Europe are currently insured. This leaves a climate protection gap for insurance of 65%.[302] Increasing climate extremes will lead to greater economic and insured losses in the EU, but the extent to which observed climate change has already contributed to growing disaster losses is still difficult to estimate. The estimation of the losses may even be at the lower bound, because only economic losses that reflect the monetised direct damages to certain assets can be measured. Losses of human life,

[302] EEA (2019) Economic losses from climate-related extremes (https://www.eea.europa.eu/ds_resolveuid/IND-182-en)

economic losses as a consequence of non-damage-related business interruption, cultural heritage or ecosystem services are not part of the estimations that are currently available.[303] This does not mean, however, that all losses should be insured.

Reliable data on insured and uninsured economic losses is necessary to inform the European and national macro-economic, microeconomic, climate adaptation and climate-related disaster risk resilience policies and to support climate adaptation efforts of all parts of society from individual citizens to the EU level. To allow comparability and aggregation of data from various sources, a set of common definitions and standards is needed.

In general, insurance markets are still influenced to a significant degree by national contract laws. Regarding data governance, currently no EU mandate exists for climate-related loss data collection and sharing, open access to economic value of assets and replacement costs and to number of natural disaster insurance policies held by Europeans. EU action to promote this will therefore mainly be indirect. Direct actions to narrow the climate protection gap do exist through, for example, the uptake of conditions in the EU funding instruments, such as 'build back better criteria' that enhance resilience and risk preparedness. In the 2013 Adaptation Strategy, no clear baseline was developed of how the market for insurance and other financial products for resilient investment would develop as a result of the above activities. Still, the measures to narrow the climate protection gap can build on existing EU tools and legislation, which is explained in the objectives and actions.

The importance for narrowing the climate protection gap has been articulated in the **interviews and stakeholder workshops**. Stakeholders mentioned that measures go beyond insurance, as it also includes public policy solutions, such as the collection of disaster loss data as well as supporting and de-risking the creation of public-private partnerships that could develop climate risk-transfer mechanisms for increasing climate risks.

The **OPC results** (Q13) show that, although respondents know where to find information about the climate-related risks they are exposed to (~20%), they are less aware of where to find financial support to invest in resilience (~11%). From Q15-16 of the OPC it follows that respondents are of the opinion that citizens at large and local authorities should have easier access to climate risk data for both historical and projected damages to people, nature and assets (compare ~20% for citizens and local authorities to ~12.5% for prospective private and public buyers and commercial owners).

Description of measure

At a micro-economic level, the European Commission lacks a systematic approach to assess, reduce, and optimally transfer climate-related disaster risk in its activities. Climate impacts are cross cutting across all sectors and consequently all EU policy areas. To adequately address mainstreaming of

[303] EIOPA (2019). Discussion paper on the protection gap for natural catastrophes. Retrieved from: https://www.eiopa.europa.eu/content/discussion-paper-protection-gap-natural-catastrophes_en

resilience, adaptation, and risk management, the EU needs tools that go beyond a supportive and facilitative role, as is the case with the climate adaptation, and disaster risk management policy frameworks. There needs to be particular consideration for the role of EU legislation to close the climate protection gap, including:

- The identification of economic losses and socio-economic vulnerability;
- The identification of vulnerable infrastructure critical to the EU economy;
- Systematically mainstreaming climate adaptation in investment decision processes;
- Developing adaptation focused risk transfer and natural disaster insurance solutions across EU Member States.

In accordance with policy coherence principles (i.e. ensure that regulation and funding take into account disaster risk before creating new exposure; reduce existing risk by building up resilience; manage residual financial risk), this will be implemented as follows:

- Funding instruments: mainstreaming of resilience, adaptation and climate risk management concerns in the design of calls and of project selection criteria and the identification of "EU interest" resilience upgrades required for interconnected critical infrastructure
- EU policy settings influencing private finance. Already in planned Renewed Sustainable Finance Strategy but stress on the importance of adaptation ambition in the revision of the Non-Financial Reporting Directive and of prudential rules.

Objectives and actions.

These two measures will specifically:

- Update Better Regulation guidelines and in particular its risk management toolbox;
- Rollout increased risk literacy training programme;
- Broaden sustainability and climate proofing and the promote enhanced insurance penetration;
- Identify vulnerability hotspots in interconnected critical infrastructure and enhance early warning systems, business continuity measures and sectoral enhance insurance penetration;

- Funding and investments instruments and EU Solidarity Fund: enhanced climate protection gap mainstreaming;
- Improving transparency on current and future climate-related disaster vulnerability of new and existing economic activities and assets;
- Revisiting prudential rules to ensure higher standards with regard to climate physical risks considerations and recognise the reduced risk profile of resilient assets and activities.

Impact pathways

A distinction is made between measure 8.2 and 8.3 impact pathways and impact; however they share the same baseline, context and rational so they are assessed in the same table.

In the table below impacts are assessed using a scale from (--/-/0/+/++) negative to positive. Impacts are assessed up to 2050 relative to the baseline. It assumes the full uptake of the measure as the increasing severity of physical climate risks on our economic activities and assets is more widely recognized, and consequently the importance of understanding the actual risk and its mitigation.

Table 33: Mini-assessment to narrowing the climate protection gap—Micro-economic policy

Impact indicator	Relevance	Indicator	Baseline	Micro-economic climate protection gap impact pathway	Envisaged impact 2050 (relative to baseline)
Economic					
Macroeconomic environment	Impacts on the economy are a hugely significant driver for action and reducing damages can be an important indicator of increased resilience.	Economic welfare (losses) (-/+)	The diverse and the pervasive impacts of a changing climate cut across all kinds of human activity. **Without** a multi-sectoral and cross-cutting approach to mainstreaming climate-related financial risk management, climate impacts will burden Member State economies with a clear North to South divide.	**Funding instruments** Indirect Impact **Influencing private finance** Indirect Impact	Measure will ensure high standards with regard to climate physical risk considerations and bring recognition to assets and activities with high risk profiles. This measure will also enhance early warning systems and roll out business continuity measures, limiting the negative impacts of hazards on the economy and shortening the recovery time. **Assessment:** Positive impact (+) Revisiting prudential rules could benefit insurers from a single market for natural disaster insurance by enhancing cooperation in cross border provision and supervision of

					natural disaster insurance. **Assessment:** Positive impact (+)
Competitiveness, trade and investment flows	Vulnerability of supply chains to impacts can be relevant and The Strategy will significantly influence the types of investments being made.	Impact on competitiveness, trade and (climate resilient) investments (+/-)	Delivery of essential services will be severely impacted. Infrastructure and assets in hazardous areas will be susceptible to impact, and may not have appropriate insurance coverage of their risks. Just-in-time supply, few alternative sources/routes/suppliers, dependence on imports can further exacerbate the negative impacts of natural disasters.	**Funding instruments** Indirect Impact **Influencing private finance** Minimal Impact	Measure will identify critical infrastructure hotspots so that they be made more resilient and in turn reduce vulnerability of supply chains to climate impacts **Assessment:** Positive impact (+)
Regulatory burden on business	Various aspects of this measure will change administrative requirements for firms applying for EU projects/funding. Influence on other EU policies, e.g. NFRD can impact on firms, but costs attributable to NFRD.	Regulatory burden on business (+/-)	Minimal (mandatory) impact	Minimal impact	
Increased innovation and research	The Strategy will guide research under Horizon Europe, and aims to encourage greater adoption of innovation.	Impact on adaptation innovation adoption (+/-)	Current models are based on incomplete historical data, and are not reliable/forward looking enough to properly identify vulnerable regions and critical infrastructure.	**Funding instruments** Indirect impact **Influencing private finance** Indirect impact	Will spur studies and modeling efforts to identify vulnerability hotspots in interconnected critical infrastructure, and enhancement of early warning systems. **Assessment:** Positive impact (+) Will improve transparency of cliamte vulnerability of economic activities and assets, which can in turn provide more reliable inputs for models and research into NATCAT insurance and disaster risk reduction. Assessment: Positive impact (+)
Public authorities (and budgets)	The Strategy will significantly impact on public spending on climate resilience, primarily through indirect routes.	Public spending on adaptation (€)	Climate-related risk is not considered throughout all decision-making processes, and there lacks allocation of clear responsibilities and climate risk-ownership. Insurance penetration remains low and residual risk financial risk management is scarce.	**Funding instruments** Direct impact	Measure will not necessarily lead to new public spending on its own, but will mainstream adapataion and the climate protection gap in calls for proposals and the design of projects. In short, insuring public spending that is being comissioned will

					postively imapct climate resilience. **Assessment:** Positive impact (++)
				Influencing private finance indirect	The consideration of climate adaptation resilience in the decision-making und budgeting by public authorities will improve the insurability of climate-related risks. **Assessment:** Positive impact (+)
Social impacts					
Employment	Impacts on the economy and in-turn on employment are a hugely significant driver for action and reducing damages and job losses can be an important indicator of increased resilience.	Employment (FTE)	The importance of business continuity is not included in natural disaster risk management efforts, and the high level of dependency on system interconnectedness negatively impacts employment across sectors after a natural disaster.	**Funding instruments** Indirect Impact	Broad climate proofing measures to reduce risks to the economy and in turn employment. Ensure that SMEs have appropriate insurance coverage for their particular vulnerabilities, by assessing vulnerable hotspots and increasing the insurance penetration rate. **Assessment:** Positive impact (+)
				Influencing private finance Minimal impact	
Income distribution, social protection and social inclusion (of particular groups)	Distributional impacts of climate change can be significant, the Strategy is intended to address and mitigate inequalities, including through better informing citizens and encouraging action. Needs to address broader questions of equity (see other impacts) such as location, economic and social cohesion, gender and also of fundamental rights.	Distributional and equity impacts (+/-)	Low socio-economic tolerance for loss and disruption. Sections of the population and the economy that do not have access to reasonably priced coverage.	**Funding instruments** Direct impact	Increasing the insurance penetration rate will ensure that all people in Europe are protected against climate risks, especially those most vulnerable. Social cohesion is another important element of risk reduction, adaptation planning, and recovery spending. Once the supply exists, the frequency, severity and/or dependency characteristics of the risks may still imply high risk-based premiums, which put the insurance products out of reach, at least for certain low-income households or small enterprises. **Assessment:** Positive impact (+) if increases in supply lead to more affordable insurance solutions. Neutral impact (0) if premiums remain high and insurance products are too
				Influencing private finance Minimal impact	

					expensive for certain groups.
Public health & safety and health systems	Increased resilience of public health and safety systems is an important goal of the Strategy.	Impact on public health and civil emergency systems (+/-)	Risk-related literacy issues. A lack of awareness leads to reduced resilience of public systems concerning risk transfer. Public-private sector cooperation remains low.	**Funding instruments** Direct impact **Influencing private finance** Minimal impact	Assessing insurance product development rules with the aim of strengthening the role of the industry in raising public climate risk awareness, risk culture and risk literacy. Additionally, inclusion of identified best practices for "impact underwriting" and for reinsurers in the adaptation taxonomy will promote prevention and resilience action by insurance policy holders. **Assessment:** Positive impact (+)
Environmental impacts					
The climate	Critical impact targeted by the strategy. Increase of resilience to climate impacts and preventing climate risks. In addition, potential synergies with mitigation may be worth considering.	Impact on climate resilience (+/-) *(possible) Synergy with climate mitigation (+/-)*	Society bears the full weight of climate-related impacts, without appropriate risk transfer solutions. There will be severe disruptions to daily life and recovery from impacts will take longer and be more arduous.	**Funding instruments** Direct impact	Mainstreaming of climate risk assessment in Strategic Environmental Assessment will enhance sustainable planning, avoid the risk of maladaptation and result in a better integration of local plans and programmes with local adaptation and disaster reduction plans. **Assessment:** Positive impact (+)
				Influencing private finance Indirect impact	Revisions to prudential rules and increased transparency of asset and economic activity vulnerability will lead to better insurance coverage for climate impacts, and thus increase resilience. **Assessment:** Positive impact (+)
Quality of natural resources/fighting pollution (water, soil, air etc.)	Strategy intends to address impacts of climate change on natural resources, e.g. forests, agriculture, marine environment.	Impact on natural resource resilience (+/-)		Minimal Impact	
Biodiversity, including flora,	Strategy intends to address impacts	Use of ecosystem-		Minimal Impact	

fauna, ecosystems and the services they provide and landscapes	of climate change on biodiversity, and to make use of Ecosystem-based solutions.	based solutions and increased resilience of ecosystems (+/-)			
Cross cutting impacts					
Impacts in developing countries	As highlighted above impacts in developing countries are important to EU economically (supply chains / markets) and socially (family ties, migration, security). Strategy aims to support improved climate resilience of 3rd (not only developing) countries.	Impact on third countries and international relations (+/-)		Minimal Impact	

Some key reports in the field

- Trinomics (2020) Analytical Report 4—The Climate Protection Gap: Support Ex-ante Impact Assessment Adaptation Strategy
- Disaster Risk Management Knowledge Centre (2020). Risk Data Hub. Retrieved from: https://drmkc.jrc.ec.europa.eu/risk-data-hub/ (13-4-2020).
- Disaster Risk Management Knowledge Centre (2020. Disaster Loss and Damage Working Group. Retrieved from: https://drmkc.jrc.ec.europa.eu/partnership/Science-Policy-Interface/Disaster-Loss-and-Damage-Working-Group (13-4-2020).
- European Commission – Directorate General for Climate Action (2017). Insurance study of weather and climate-related disaster risk. Retrieved from: https://op.europa.eu/en/publication-detail/-/publication/4f366956-a19e-11e7-b92d-01aa75ed71a1/language-en (13-4-2020).
- European Commission (2017) Overview of natural and man-made risks that the EU may face. Retrieved from: https://op.europa.eu/en/publication-detail/-/publication/285d038f-b543-11e7-837e-01aa75ed71a1 (13-4-2020).
- European Environment Agency (2017). Climate change impacts and vulnerability in Europe 2016. An indicator-based report. EEA Report No 1/2017. Retrieved from: https://www.eea.europa.eu/publications/climate-change-impacts-and-vulnerability-2016 (13-4-2020).
- European Environment Agency (2017). Climate change adaptation and disaster risk reduction in Europe. Enhancing coherence of the knowledge base, policies and practice. Retrieved from: https://www.eea.europa.eu/publications/climate-change-adaptation-and-disaster (4-13-2020).

- European Insurance and Occupational Pension Authority (2019). Discussion paper on the protection gap for natural catastrophes. Retrieved from: https://www.eiopa.europa.eu/content/discussion-paper-protection-gap-natural-catastrophes_en (13-4-2020).
- European Insurance and Occupational Pension Authority (2019). Opinion on Sustainability within Solvency II. Retrieved from: https://www.eiopa.europa.eu/content/opinion-sustainability-within-solvency-ii_en (13-4-2020).
- European Technical Expert Group on Sustainable Finance (2020). Financing a sustainable European Economy. Taxonomy Report: Technical Annex.
- Geneva Association (2018). Climate Change and the Insurance Industry: Taking Action as Risk Managers and Investors. Perspectives from C-level executives in the insurance industry. Retrieved from: https://www.genevaassociation.org/research-topics/extreme-events-and-climate-risk/climate-change-and-insurance-industry-taking-action (13-4-2020).
- Hudson et al. (2019). An assessment of best practices of extreme weather insurance and directions for a more resilient society. Retrieved from: https://www.tandfonline.com/doi/full/10.1080/17477891.2019.1608148 (13-4-2020).
- Insurance Europe (2019). Annual report 2017-2018. Retrieved from: https://insuranceeurope.eu/annual-report-2017-2018 (13-4-2020)
- Insurance Europe (2015). National natcat insurance schemes. Retrieved from: https://www.insuranceeurope.eu/natural-catastrophes
- IPCC (2012). Managing the Risks of Extreme Events and Disasters to Advance Climate
- Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, UK, and New York, NY, USA, 582 pp.
- Jarzabkowski, P., K. Chalkias, D. Clarke, E. Iyahen, D. Stadtmueller & A. Zwick. (2019). Insurance for climate adaptation: Opportunities and limitations." Rotterdam and Washington, DC. Available online at www.gca.org.
- Joint Research Centre (2018). Mapping of risk web-platforms and risk data: collection of good practices. Retrieved from: https://doi.org/10.2760/93157 (13-4-2020).
- OECD DAC Statistics (2020). Insurance indicators. Retrieved from: https://stats.oecd.org/Index.aspx?DatasetCode=INSIND (13-4-2020)
- OECD DAC (2016). Financial Management of Flood Risk. Retrieved from: https://www.oecd.org/daf/fin/insurance/OECD-Financial-Management-of-Flood-Risk.pdf (13-4-2020)

- Munich Climate Insurance Initiative (2019). Closing the protection gap. Retrieved from: http://www.climate-insurance.org/about/who-we-are/ (13-4-2020).
- Surminski & Eldridge (2015). Flood insurance in England: an assessment of the current and newly proposed insurance scheme in the context of rising flood risk. Journal of Flood Risk Management. Retrieved from: http://eprints.lse.ac.uk/66256/ (4-14-2020).

ACTION 9: Supporting partner countries in their efforts on climate change, disaster preparedness, and comprehensive risk management approaches

MEASURE 9.1: Support upgrade and implementation of NDCs and NAPs , by providing technical and financial assistance dedicated to: building capacity at national and sub-national level; assessing exposure and vulnerabilities; developing adaptation plans in line with national priorities and vulnerabilities; promoting climate-proof structural governance reforms; implementing monitoring and evaluation schemes to assess progress towards climate change resilience; enhancing coherence with national and local disaster risk reduction strategies and environmental sustainability strategies; promoting nature-based solutions and ecosystem-based approaches, especially in coastal areas.

MEASURE 9.4: Work with leading institutions in Africa, the Caribbean and the Pacific to support regional climate change adaptation and disaster risk management approaches building on ongoing initiatives such as the Africa Adaptation Initiative, and develop regional adaptation plans and action.

Baseline, context and rationale

National climate and adaptation strategies often fail to consider all the impacts on climate change. For instance, a 2018 GWP analysis of 80 NDCs (including most EU partner countries) revealed that even though water drives climate adaptation action (89 % plans) few countries include measures to robust their water management approaches. [304] Moreover, it has been shown that National Adaptation Plans (NAPs) are typically failing to include a broad range of stakeholders in the planning process, and greater attention needs to be given to increasing participation and coordination in the national adaptation planning processes.[305]

[304] GWP (2019) Addressing Water in National Adaptation Plans. Available at: https://www.gwp.org/en/About/more/news/2019/addressing-water-in-national-adaptation-plans/
[305] Woodruff, Sierra C., and Patrick Regan. "Quality of national adaptation plans and opportunities for improvement." Mitigation and Adaptation Strategies for Global Change 24.1 (2019): 53-71.

To solve these gaps, the EU can support partner countries to adapt to the effects of climate change impacts at all levels: not only in terms of providing resources and prioritisation, but also in terms of improving effectiveness of action and support. [306] Accordingly, the European Green Deal contains four actions under the objective of positioning the EU as a global leader, including continue to lead the international climate and biodiversity negotiations, further strengthening the international policy framework, and undertaking bilateral efforts to induce partners to act and to ensure comparability of action and policies.[307] As, a according to the 2018 Evaluation, the 2013 Strategy failed to address broader international climate adaptation issues, the new Strategy will increase the support to partner countries seeking to use potential for cooperation between the EU and other economies in this regard.

Description of measures

The following actions will be implemented to supporting partner countries in their efforts on climate change, disaster preparedness, and comprehensive risk management approaches

Objectives and actions:

Support upgrade and implementation of NDCs and NAPs by providing technical and financial assistance dedicated to: building capacity at national and sub-national level, developing adaptation plans in line with national priorities and vulnerabilities; supporting climate-proof structural governance reforms; implementing monitoring and evaluation schemes to assess progress towards climate change resilience; enhancing coherence with national and local disaster risk reduction strategies and environmental sustainability strategies; promoting nature-based solutions and ecosystem-based approaches, especially in coastal areas. Work with leading institutions in Africa, the Caribbean, the Pacific and Asia sub-regions to promote and support climate change adaptation and disaster risk management approaches, and develop regional adaptation plans and action: Propose regional programmes in Africa (e.g. with AU or regional economic communities) to develop regional adaptation and DRR strategies.

Impact pathways

In the table below impacts are assessed using a scale from (--/-/0/+/++) negative to positive. Impacts are assessed up to 2050 relative to the baseline. It assumes the full uptake of the measure as the increasing severity of physical climate risks is globally more widely recognized, and consequently the relevance of support to countries beyond EU borders that are prone to the effects of climate change.

[306] European Commission (2020) Adaptation to Climate Change Blueprint for a new, more ambitious EU strategy, available at - https://ec.europa.eu/clima/sites/clima/files/consultations/docs/0037/blueprint_en.pdf
[307] European Commission (2019) The European Green Deal, section 3 'The EU as a Global Leader'.

Table 34: Mini-assessment on supporting partner countries

Impact indicator	Relevance	Indicator	Baseline	Supporting partner countries	Envisaged impact 2050 (relative to baseline)
Economic					
Macroeconomic environment	Impacts on the economy are a hugely significant driver for action and reducing damages can be an important indicator of increased resilience.	Economic welfare (losses) (-/+)	The findings of PESETA IV confirm a more comprehensive analysis performed in PESETA III, which showed that international spill-over effects could increase the internal EU welfare loss by approximately 20%.	Indirect impact	The new Strategy will give support to partner countries to develop coherent and effective climate adaptation and disaster risk reduction strategies. Therefore, it is expected that the impacts of international spill-over effects on the EU's macro-economic environment, will be reduced to some extent by this measure **Assessment: Positive impact (+)**
Competitiveness, trade and investment flows	Vulnerability of supply chains to impacts can be relevant and The Strategy will significantly influence the types of investments being made.	Impact on competitiveness, trade and (climate resilient) investments (+/-)		Minimal Impact	Minimal impact (for EU)
Regulatory burden on business	Measure will not significantly affect EU firms costs.	Regulatory burden on business (+/-)	Minimal Impact	Minimal Impact	
Increased innovation and research	The Strategy will guide research under Horizon Europe and aims to encourage greater adoption of innovation.	Impact on adaptation innovation adoption (+/-)		Minimal Impact	Minimal impact (for EU)
Public authorities (and budgets)	The Strategy will significantly impact on public spending on climate resilience, primarily through indirect routes.	Public spending on adaptation (€)		Minimal Impact	Minimal impact (for EU)
Social impacts					
Employment	Impacts on the economy and in-turn on employment are a hugely significant driver for action and reducing damages and job losses can be an important indicator of increased resilience.	Employment (FTE)		Minimal impact	Minimal impact (for EU)

Income distribution, social protection and social inclusion (of particular groups)	Distributional impacts of climate change can be significant, the Strategy is intended to address and mitigate inequalities, including through better informing citizens and encouraging action. Needs to address broader questions of equity (see other impacts) such as location, economic and social cohesion, gender and of fundamental rights.	Distributional and equity impacts (+/-)		Minimal impact	Minimal impact (for EU)
Public health & safety and health systems	Increased resilience of public health and safety systems is an important goal of the Strategy.	Impact on public health and civil emergency systems (+/-)		Minimal impact	Minimal impact (for EU)
Environmental impacts					
The climate	Critical impact targeted by the strategy. Increase of resilience to climate impacts and preventing climate risks. In addition, potential synergies with mitigation may be worth considering.	Impact on climate resilience (+/-) *(possible) Synergy with climate mitigation (+/-)*		Direct impact	By enhancing the EU cooperation and knowledge exchange with partner countries regarding climate adaptation and disaster risk reduction plans, the new Strategy will contribute to improving the resilience to climate change impacts in partner countries. **Assessment: Positive impact (++)**
Quality of natural resources/fighting pollution (water, soil, air etc.)	Strategy intends to address impacts of climate change on natural resources, e.g. forests, agriculture, marine environment.	Impact on natural resource resilience (+/-)		Indirect impact	The new EU Adaptation Strategy will encourage partner countries to address the impacts of climate change on the quality of natural resources (water, soil, air, etc.) in their adaptation and DRR plans. As a result, it is expected that the impacts on the quality and availability of natural resources globally will be alleviated to some extent. **Assessment: Positive impact (+)**
Biodiversity, including flora,	Strategy intends to address impacts of	Use of ecosystem-based		Indirect impact	Biodiversity is a priority of the EU's external

fauna, ecosystems and the services they provide and landscapes	climate change on biodiversity, and to make use of Ecosystem-based solutions.	solutions and increased resilience of ecosystems (+/-)			action and an integral part of efforts to meet the United Nations Sustainable Development Goals[308]. In accordance, the new EU Adaptation Strategy will encourage partner countries to include the impacts of climate change on biodiversity in their adaptation and DRR plans, especially through the deployment of NbS. **Assessment: Positive impact (+)**
Cross cutting impacts					
Impacts in developing countries	As highlighted above impacts in developing countries are important to EU economically (supply chains / markets) and socially (family ties, migration, security). Strategy aims to support improved climate resilience of 3rd (not only developing) countries.	Impact on third countries and international relations (+/-)		Direct Impact	Critical impact targeted by this measure. By working with leading regional institutions (e.g. with AU or regional economic communities), the new Strategy is expected to have an impact in developing countries and their adaptation and DRR strategies. **Assessment: Positive impact (++)**

Some key reports in the field

- European Union, 2019. On the implementation of the European Union's instruments for financing external actions in 2018
- The World Bank (2019) LIFELINES The Resilient Infrastructure Opportunity
- UNFCCC NDCs, Guidelines financing needs –
- UNEP – Gap report, cost of inaction, World Bank lifeline. Direct, indirect impact, indication of costs
- Commission RIO markers, report OECD

[308] European Commission (2020) EU Biodiversity Strategy for 2030, from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, COM/2020/380 final, available at - https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1590574123338&uri=CELEX:52020DC0380

ACTION 10: Scaling up international adaptation finance and disaster risk financing, including by unlocking innovative finance and mobilising the private sector.

MEASURE 10.3: Use the External Investment Plan and the European Fund for Sustainable Development + amongst other innovative financial instruments to leverage private sector finance for climate change adaptation, in line with the EU Sustainable Finance Taxonomy, and promote the engagement of partner countries in the International Platform for Sustainable Finance.

MEASURE 10.5: Use the External Investment Plan and the European Fund for Sustainable Development + amongst other innovative financial instruments to leverage private sector finance for climate change adaptation, in line with the EU Sustainable Finance Taxonomy, and promote the engagement of partner countries in the International Platform for Sustainable Finance.

Baseline, context and rationale

On average, adaptation finance has accounted for about 5% of climate finance since 2015/2016 and, though it rose to US$30 billion in 2017/2018, still falls far from the estimated US$230 billion annual requirement.[309] [310] In line with these needs, the External Investment Plan (EIP) is an EU initiative designed to support investments into Africa and other countries by using public money to attract private investment, to foster sustainable and inclusive economic and social development, while addressing specific socioeconomic root causes of migration. Pillar 3 of the EIP is based on key the following building blocks:

- deepening the investment climate analysis (including through technical assistance facilities such as the Structural Reform Facility for the Eastern Partnership),
- engaging in structured public-private dialogue (such as Sustainable Business for Africa – SB4A – Platform), in synergy with other tools such as EU trade and investment policies and EU Economic Diplomacy to identify obstacles and reforms needed.
- Finally, prioritised interventions to support adequate reforms, capacity building of public and private sector, value addition and entrepreneurship, can address investors' perceived risks.

[309] EDPM 2019 Boosting EU Climate Finance: Mitigate More Without Neglecting Adaptation In Poorer Countries
[310] CPI. 2019. Global landscape of climate finance 2019. Climate Policy Initiative

As a domestic reference, InvestEU (EUR 10.5 billion budget provision), will be the key EU instrument to crowd in private capital to support investments in policy areas essential for achieving the European Green Deal objectives: including renewable energy, energy efficiency, decarbonised energy infrastructure or research and innovation in green technologies. Today, in the context of the green recovery for the climate and environmental proofing of infrastructure investments, Member States are encouraged to apply the guidance from the Commission established under the InvestEU Regulation. For the climate and environmental proofing of other types of investment than infrastructure, Member States are encouraged to apply climate proofing as laid down in the guidance from the Commission on sustainability proofing under the InvestEU Regulation.[311]

At the international level, the International Platform for Sustainable Finance (IPSF) is confirmed by 14 members that together represent 50% of global GHG emissions, 50% of the world population and 45% of the global GDP.[312] The ultimate objective of the IPSF is twofold: to scale up the mobilisation of private capital towards environmentally sustainable finance to promote integrated markets for environmentally sustainable finance.

In the OPC conducted for this Assessment, 57% of respondents strongly agreed that financial support for adaptation to climate change is insufficient, and 53% strongly agreed that businesses and the financial sector are not appropriately involved in adaptation efforts.

Objectives and actions:

- Use the External Investment Plan (EIP) and the EFTA
- (EFSD) to leverage private sector finance for climate change adaptation, in line with the EU Sustainable Finance Taxonomy
- Promote the engagement of partner countries in the International Platform for Sustainable Finance (IPSF)
- Require climate proofing of all EU external investments, including through grants, guarantees and blending instruments
- Adapt/translate the guidance on sustainability proofing for InvestEU (including the three pillars on climate proofing, environmental proofing, and social proofing) for all external investments.

[311] European Commission (2020) Guidance to Member States – Recovery and Resilience Plans Staff working Document. Available at: https://ec.europa.eu/info/sites/info/files/3_en_document_travail_service_part1_v3_en.pdf
[312] European Commission (2020) International platform on sustainable finance.
Available at: https://ec.europa.eu/info/sites/info/files/business_economy_euro/banking_and_finance/documents/international-platform-sustainable-finance-factsheet_en.pdf

Impact pathways

In the table below impacts are assessed using a scale from (--/-/0/+/++) negative to positive. Impacts are assessed up to 2050 relative to the baseline.

Table 35: Mini-assessment on scaling up international adaptation and risk financing

Impact indicator	Relevance	Indicator	Baseline	Scaling up international adaptation and risk financing	Envisaged impact 2050 (relative to baseline)
Economic					
Macroeconomic environment	Impacts on the economy are a hugely significant driver for action and reducing damages can be an important indicator of increased resilience.	Economic welfare (losses) (-/+)	The openness of the EU international market accounts for EUR 2 791 billion of exports and EUR 2 578 billion of imports in goods and services. Economic openness has brought, and will keep on bringing, significant advantages to the EU, given that more than 30 million jobs in the EU depend on external trade and that 90% of global economic growth in the next 15 years is expected to be generated outside Europe.[313]	Indirect impact	By scaling up international adaptation finance and disaster risk financing, the new Strategy is expected to have a positive impact on the international EU exchange with partner countries, as these becomes more resilient to the effects of climate change. **Assessment: Positive impact (+)**
Competitiveness, trade and investment flows	Vulnerability of supply chains to impacts can be relevant and The Strategy will significantly influence the types of investments being made.	Impact on competitiveness, trade and (climate resilient) investments (+/-)	While some countries targeted by the EIP (e.g. Egypt, Kenya, Morocco, Nigeria and South Africa) attract collectively 58% of total FDI (Foreign Direct Investment) in 2016, less advanced and more fragile countries face systemic challenges to attract sustainable private investment. The EU is Africa's biggest investor, with EU Member States holding approximately 40% of FDI stock worth EUR 291 billion in 2016.[314]	Indirect impact	Despite there being no intention to bind third countries on their own sustainability activities, by leveraging climate finance in line with the EU Taxonomy at the international level, it is expected that this measure and disclosure of obligations on financial products for EU corporations will create implications for international actors. **Assessment: Positive impact (+)**

[313] European Commission (2019) Fact Sheets on the European Union - 2020 The European Union and its trade partners.
Available at: https://www.europarl.europa.eu/factsheets/en/sheet/160/the-european-union-and-its-trade-partners

[314] European Commission (2019) Handbook on Improving the Investment Climate through EU Action, Implementation of Pillar 3 in the integrated approach of the External Investment Plan.

Regulatory burden on business	Requirements for climate proofing of investments will change nature of EU investments. Will primarily affect EU institutions. Firms implementing investments will need to offer climate resilient products and services, but this will be voluntary and to benefit from access to funding.	Regulatory burden on business (+/-)	Minimal impact.	Minimal impact.	
Increased innovation and research	The Strategy will guide research under Horizon Europe and aims to encourage greater adoption of innovation.	Impact on adaptation innovation adoption (+/-)		Indirect impact	The increase in the private sector financing for climate change adaptation supported by the EIP and EFSD is expected to foster innovation and entrepreneurship in the partner countries. **Assessment: Positive impact (+)**
Public authorities (and budgets)	The Strategy will significantly impact on public spending on climate resilience, primarily through indirect routes.	Public spending on adaptation (€)	The share of EU climate finance targeted at adaptation is increasing, with particular focus on the most vulnerable countries. In 2018 alone, the EU, its Member States and the EIB provided EUR 21.7 billion in public climate finance, increasingly supporting climate change adaptation. In addition, roughly 50% of international climate finance from the EU budget (excluding Member State funds) was dedicated to adaptation projects in the period 2014-2019.[315]	Direct impact	**Assessment: Positive impact (++)**
Social impacts					
Employment	Impacts on the economy and in-turn on employment are a hugely significant driver for action and reducing damages and job losses can be an important indicator of	Employment (FTE)		Indirect impact	The private sector holds great potential for generating jobs and, therefore, sustainable investments in countries receiving international climate finance aid can generate growth opportunities in medium

[315] European Commission (2020) Adaptation to Climate Change Blueprint for a new, more ambitious EU strategy, available at - https://ec.europa.eu/clima/sites/clima/files/consultations/docs/0037/blueprint_en.pdf

	increased resilience.				and long-term. **Assessment: Positive impact (+)**
Income distribution, social protection and social inclusion (of particular groups)	Distributional impacts of climate change can be significant, the Strategy is intended to address and mitigate inequalities, including through better informing citizens and encouraging action. Needs to address broader questions of equity (see other impacts) such as location, economic and social cohesion, gender and of fundamental rights.	Distributional and equity impacts (+/-)		Indirect impact	**Assessment: Positive impact (+)**
Public health & safety and health systems	Increased resilience of public health and safety systems is an important goal of the Strategy.	Impact on public health and civil emergency systems (+/-)		Minimal impact	
Environmental impacts					
The climate	Critical impact targeted by the strategy. Increase of resilience to climate impacts and preventing climate risks. In addition, potential synergies with mitigation may be worth considering.	Impact on climate resilience (+/-) *(possible) Synergy with climate mitigation (+/-)*	Currently, only few projects of the EFSD incorporate sustainability policy reforms as an explicit objective.[316] In the MFF (2014-2020), climate proofing was neither defined nor widely and consistently applied across EU funds and programmes.	Direct impact	This measure will promote the engagement of partner countries in the IPSF. As a result, it is expected that more countries will join the platform, leading to the overall increase of climate adaptation efforts. Moreover, by the use of the EIP and the EFSD to leverage private sector finance, it is expected that more funded projects incorporate climate adaptation as key specific objective. Finally, the climate proofing requirement of all EU investments will increase the climate resilience of new infrastructure abroad.

[316] https://ec.europa.eu/eu-external-investment-plan/about-plan/progress_en

					Assessment: Positive impact (++)
Quality of natural resources/fighting pollution (water, soil, air etc.)	Strategy intends to address impacts of climate change on natural resources, e.g. forests, agriculture, marine environment.	Impact on natural resource resilience (+/-)		Minimal impact	
Biodiversity, including flora, fauna, ecosystems and the services they provide and landscapes	Strategy intends to address impacts of climate change on biodiversity, and to make use of Ecosystem-based solutions.	Use of ecosystem-based solutions and increased resilience of ecosystems (+/-)		Minimal impact	
Cross cutting impacts					
Impacts in developing countries	As highlighted above impacts in developing countries are important to EU economically (supply chains / markets) and socially (family ties, migration, security). Strategy aims to support improved climate resilience of 3rd (not only developing) countries.	Impact on third countries and international relations (+/-)		Direct impact	This measure will promote the engagement of partner countries in the IPSF. As a result, it is expected that more developing countries will join the platform, leading to an improved exchange and dissemination of information to promote best practices and lessons learnt in environmentally sustainable finance. **Assessment: Positive impact (++)**

Some key reports in the field

- External Investment Plan
- Implementation Report of the EFSD and the EFSD Guarantee Fund
- European Commission (2019) Handbook on Improving the Investment Climate through EU Action, Implementation of Pillar 3 in the integrated approach of the External Investment Plan
- European Commission (2019) Strengthening the EU's partnership with Africa.

- European Commission (2020) International platform on sustainable finance. Available at: https://ec.europa.eu/info/sites/info/files/business_economy_euro/banking_and_finance/documents/international-platform-sustainable-finance-factsheet_en.pdf
- EU Technical Expert Group on Sustainable Finance (2020) Taxonomy: Final report of the Technical Expert Group on Sustainable Finance. Available at: https://ec.europa.eu/info/files/200309-sustainable-finance-teg-final-report-taxonomy_en
- Navigant/Guidehouse (2019) Aligning EU budget expenditures with the objectives of the Paris Agreement

ACTION 11: Strengthening EU engagement globally and learning from adaptation frontrunners.

MEASURE 11. 5: Strengthen the production and delivery of, and access to, user-friendly and timely climate data and information (climate services), in particular through the promotion of space based application, the use of Copernicus Climate Change Services and Emergency Management Services in partner countries, thus building on the existing European investments in climate research, data, information and services.

Baseline, context and rationale

Copernicus is the European Union's Earth Observation Programme, consisting of a complex set of systems that collect data from multiple sources: earth observation satellites and *in situ* sensors such as ground stations, airborne and sea-borne sensors.[317] To respond to the user demands, the Copernicus Service Component is organised into six thematic services: the Atmosphere Monitoring Service, Marine Environment Monitoring Service, Land Monitoring Service, Climate Change Service, Emergency Management Service, and Security Service. In particular, the objective of the Copernicus Climate Change Service (C3S) is to provide knowledge-based support to mitigation and adaptation policies, while the Copernicus Emergency Management Service (EMS) seeks to provide on-demand detailed information for selected emergencies that arise from natural or man-made disasters anywhere in the world.

Space infrastructure and data from international partner countries are beneficial for the Copernicus programme in a variety of areas (e.g. data processing, integration of third-party data into the Copernicus data system, data assimilation into models, and products of the Copernicus services). In

[317] Climate Adapt Copernicus Climate Change Service. Available at: https://climate-adapt.eea.europa.eu/knowledge/adaptation-information/climate-services#:~:text=Copernicus%20is%20the%20European%20Union's%20Earth%20Observation%20Programme.&text=Copernicus%20Climate%20Change%20Service%20gives,multiple%20Essential%20Climate%20Variables%20(ECV)

turn, partner countries benefit from the multiple advantages of using data from the Copernicus programme, including improved civil protection responses, improved risk and vulnerability assessments, and monitoring of environmental indicators and risks and, as a result, reduced areas burnt by wildfires, better compliance monitoring of environmental policies, and reduced damages on ecosystems, among others. Until today, the Copernicus programme has concluded cooperation agreements with countries such as the United States, Australia, Brazil, Colombia, Chile, India, Ukraine, Serbia, and the African Union, while other countries have shown interest to conclude additional arrangements in the future.[318]

The 2020 Copernicus Work Program 2020[319] outlines the strategy to increase the international visibility of Copernicus, through the participation in various fora and conferences, supported by international partners, such as GEO, CEOS, WMO, FAO, UNEP, COP, etc. The prominent position of the European Commission, as co-chair of the Group of Earth Observation (GEO) makes it the ideal forum to expose European know-how in earth observation and liaise with the international community to exchange expertise to turn earth observation data into actionable knowledge. According to the plan, specific contracts would be used in order to undertake sessions, workshops, seminars performed by international partners. Besides, ahead of the Horizon Europe Strategic Plan, the Copernicus Research and Development programme expressed its priorities and needs for the future in the framework of Horizon Europe in the document *Copernicus programme: research & development recommendations for Horizon Europe*[320]. Therein, cooperation with international partners is seen as key to promoting the uptake of Copernicus globally, exploiting possibilities for integrating in-situ, space data, and information technologies. Further, it was outlined that following the Copernicus full, free and open data policy, the Commission seeks to facilitate access to Copernicus data and information for interested international partners, with third countries being of special interest to using Copernicus data to jointly develop processing methods, services and/or products which serve local user needs and/or enhance the Copernicus global product quality.

Objectives and actions:

- Strengthen the production and delivery of user-friendly and timely climate information and data (climate services) in partner countries.

[318] Copernicus (n.d.) International cooperation on data exchange. Available at: https://www.copernicus.eu/en/international-cooperation-area-data-exchange
[319] European Commission (2019) Annex to the Commission Implementing Decision on the financing of the Copernicus programme and on the adoption of the work programme for 2020. Available at: https://www.copernicus.eu/en/documentation/work-programmes/work-programmes
[320] Copernicus Research and Development (2019) Copernicus programme: research & development recommendations for Horizon Europe. https://www.copernicus.eu/sites/default/files/inline-images/R%26D%20recommendations%20for%20HE.pdf

- Promote the use of space-based applications, in particular using Copernicus Climate Change Services, and Emergency Management Services in partner countries.
- Take advantage of the GEO recognised partnership of more than 100 countries to facilitate access and use of Earth observation derived products and services.

Cost

For reference, in 2020 the budget for communication and dissemination activities of the Copernicus Program was 1 200 000, for international visibility EUR 50 000 were allocated[321]. The European contribution to the GEO initiative reaches an amount of € 1 000 000 on an annual basis (via its Research & Innovation Programme).

Impact pathways

In the table below impacts are assessed using a scale from (--/-/0/+/++) negative to positive. Impacts are assessed up to 2050 relative to the baseline. It assumes the full uptake of the measure as the increasing severity of physical climate risks is more widely recognised, and consequently the relevance of sharing information between countries and regions.

Table 36: Mini-assessment on strengthening EU adaptation engagement globally

Impact indicator	Relevance	Indicator	Baseline	Impact pathway	Envisaged impact 2050 (relative to baseline)
Economic					
Macroeconomic environment	Impacts on the economy are a hugely significant driver for action and reducing damages can be an important indicator of increased resilience.	Economic welfare (losses) (-/+)		Minimal impact	Minimal impact (for EU)
Competitiveness, trade, and investment flows	Vulnerability of supply chains to impacts can be relevant and The Strategy will significantly	Impact on competitiveness, trade and (climate resilient)		Minimal impact	Minimal impact (for EU)

[321] European Commission (2019) Annex to the Commission Implementing Decision On The Financing Of The Copernicus Programme And On The Adoption Of The Work Programme For 2020. Available at: https://www.copernicus.eu/en/documentation/work-programmes/work-programmes

	influence the types of investments being made.	investments (+/-)			
Regulatory burden on business	Minimal impact.	Regulatory burden on business (+/-)	Minimal impact.	Minimal impact.	
Increased innovation and research	The Strategy will guide research under Horizon Europe and aims to encourage greater adoption of innovation.	Impact on adaptation innovation adoption (+/-)		Direct impact	By diffusing the knowledge of data, information and products result from the work of the Copernicus programme, the new EU Strategy is expected to increase the innovation in partner countries, as best practices are shared. **Assessment: Positive impact (+)**
Public authorities (and budgets)	The Strategy will significantly impact on public spending on climate resilience, primarily through indirect routes.	Public spending on adaptation (€)		Minimal impact	Minimal impact (for EU)
Social impacts					
Employment	Impacts on the economy and in-turn on employment are a hugely significant driver for action and reducing damages and job losses can be an important indicator of increased resilience.	Employment (FTE)		Minimal impact	Minimal impact
Income distribution, social protection and social inclusion (of particular groups)	Distributional impacts of climate change can be significant, the Strategy is intended to address and mitigate inequalities, including through better informing citizens and encouraging action. Needs to address broader questions of equity (see other impacts) such as location, economic and social cohesion, gender and also of fundamental rights.	Distributional and equity impacts (+/-)		Indirect impact	The social benefits of the Copernicus programme are manifold: reduced casualties in natural disasters, improved robustness for food security, improved management of air quality in cities, among many others. It can also support countries/regions in their efforts to implement effective disaster risk financing strategies by supporting the issuance of payouts in the context of risk polling mechanisms or deployment of social safety nets programmes in the wake of a disaster promoting social protection. The expanded use of space-based data can help most

					vulnerable countries and communities without sufficient technical and financial resources to improve their regular monitoring of urban development (i.e. human settlements) **Assessment: Positive impact (+)**
Public health & safety and health systems	Increased resilience of public health and safety systems is an important goal of the Strategy.	Impact on public health and civil emergency systems (+/-)	Copernicus provides the necessary datasets to develop tools that can raise awareness on environmental health (e.g. on pollen dispersion or UV index).	Indirect impact	By encouraging partner countries to use Copernicus data, the new Strategy will help countries to increase the resilience of the health systems by improving the monitoring of air, noise pollution, and so-called Urban Health Islands. Moreover, countries can improve their civil protection responses and thus, the services provided. **Assessment: Positive impact (+)**
Environmental impacts					
The climate	Critical impact targeted by the strategy. Increase of resilience to climate impacts and preventing climate risks. In addition, potential synergies with mitigation may be worth considering.	Impact on climate resilience (+/-) *(possible) Synergy with climate mitigation (+/-)*		Direct impact	Improved visibility and use of the Copernicus programme internationally is expected to raise awareness by the general public, by partner organisations and partner organisations in and outside Europe. By improving natural resources, management (e.g. water efficiency for industrial production) EU partner countries can improve their resilience to the effects of climate change. In the case of climate mitigation, this measure can have a positive impact in sectors such as energy, whereby the prediction of the availability of resources for renewable energy production can decrease the reliance on fossil fuels and, therefore, the reduction of GHG, **Assessment: Positive impact (+)**
Quality of natural resources/fighting pollution (water, soil, air etc.)	Strategy intends to address impacts of climate change on natural resources, e.g. forests, agriculture, marine environment.	Impact on natural resource resilience (+/-)	Early warning and forecasts have a great impact on the response to natural disasters. One of Copernicus applications is the **Fire Risk Index** at short and long term, assessing the risk of	Indirect impact	The increased use, production, and delivery of user-friendly and timely climate data through space-based applications in EU-partner countries is expected to have multiple impacts on natural resources. Examples include reduced areas burnt by wildfires due to

			fire ignition and the difficulty to control it. In Africa, the cooperation arrangement with Copernicus enables African Earth Observation data users to access to Sentinel Satellites data using high bandwidth terrestrial network connections between Europe and Africa, helping users to monitor their environment, crops, water bodies and coastal ecosystems among others.[322]		improved civil protection responses, better compliance monitoring of environmental policies, reduced damages on ecosystems (oil spills). Besides, given that, as a result of Copernicus data, the consumption of water, fertilisers, and pesticides has decreased through Earth Observation-based smart farming service. It can be expected that these benefits will increase as more countries around the world use the available data. **Assessment: Positive impact (+)**
Biodiversity, including flora, fauna, ecosystems and the services they provide and landscapes	Strategy intends to address impacts of climate change on biodiversity, and to make use of Ecosystem-based solutions.	Use of ecosystem-based solutions and increased resilience of ecosystems (+/-)	Copernicus products are enhancing a growing set of different analyses to assess the conservation status of forests by covering more areas and by early change detection, thus helping to ensure the sustainability of the ecosystem and the compliance to global directives	Indirect impact	By promoting the use of space-based data, the new Strategy will contribute to the increased resilience of ecosystems in partner countries. The expanded provision of accurate forest data and mapping is expected to help forest authorities to detect a change in the land cover and land use, and minimise problems related to deforestation and unsustainable land use management. **Assessment: Positive impact (+)**
Cross-cutting impacts					
Impacts in developing countries	As highlighted above impacts in developing countries are important to the EU economically (supply chains / markets) and socially (family ties, migration, security). Strategy aims to support improved climate resilience of 3rd (not only developing) countries.	Impact on third countries and international relations (+/-)	The Climate Change Service of the Copernicus Program has already been identified by the Commission, as a major contributor to climate products for a range of climate adaptation issues as well as analyses to the World Meteorological Organization (WMO) Regional Climate Centres of the African, Caribbean, and Pacific region. As of September 2020, developing	Direct impact	Improved visibility and use of the Copernicus programme internationally is expected to raise awareness by the general public, by partner organisations and partner organisations in and outside Europe. In consequence, resilience to the effects of climate change in partner countries is expected to improve. **Assessment: Positive impact (++)**

[322] GMES, and Africa (n.d) A Joint Support Programme of the African Union Commission and the European Commission http://gmes4africa.blogspot.com/

			countries that are part of the international cooperation activities the Copernicus Programme are United States, Australia, Brazil, Colombia, Chile, India, Ukraine, Serbia, and the African Union. In February, the Philippines announced that it would start an Earth satellite data collaboration with EU's Copernicus monitor deforestation, carbon sequestration, and coastal changes in the Southeast Asian nation.[323]		

Some key reports in the field

- European Commission (2019) Copernicus Market Report 2019. Prepared by PwC. Available at: https://www.copernicus.eu/sites/default/files/2019-02/PwC_Copernicus_Market_Report_2019_PDF_version.pdf
- Copernicus (2019) Copernicus Programme-Research & development. Recommendations for Horizon Europe – Working Document. Available at: https://www.copernicus.eu/sites/default/files/inline-images/R%26D%20recommendations%20for%20HE.pdf
- European Commission (2019) Annex to the Commission Implementing Decision On The Financing Of The Copernicus Programme And On The Adoption Of The Work Programme For 2020. Available at: https://www.copernicus.eu/en/documentation/work-programmes/work-programmes
- Group on Earth Observation (2021) Highlights Report 2020. Available at: https://www.geohighlightsreport2020.org/
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[323] Mongabay (2020). Press release. Philippines turns to EU's Copernicus in Earth satellite data collaboration. Available at: https://news.mongabay.com/2020/02/philippines-turns-to-eus-copernicus-in-earth-satellite-data-collaboration/

ACTION 12: Adaptation Solutions / Horizon Europe Mission on adaptation to Climate Change, including Societal Transformation

MEASURE 12.1: Implement the Horizon Europe Mission on Adaptation to Climate Change, including Societal Transformation with the objectives of preparing Europe, accelerating the transition, and building deep resilience.

Baseline, context and rationale

Horizon Europe is the EU's funding programme for research and innovation, which will run from 2021 to 2027 with a budget of ~€95 billion. As part of Horizon Europe, the Mission on Adaptation to Climate Change will support adaptation by connecting citizens with science and public policy. It was chosen to help maximise the impact of the EU's support to research and innovation with a focus on solutions and preparedness for the impacts of climate change. The mission seeks societal transformation through behavioural changes and addressing vulnerable communities. It has a mission board of 15 experts tasked with identifying one or more specific missions for implementation under Horizon Europe. In September 2020, the Mission board presented their proposals to the European Commission in the report **A Climate Resilient Europe: Prepare Europe for climate disruptions and accelerate the transformation to a climate-resilient and just Europe by 2030.**

Description of measure

The outputs of the Horizon Europe Mission align with the Adaptation Strategy, and the Strategy in turn can be used to implement the targets set out in the mission. There are three main objectives of the mission, with the ultimate goal to accelerate the transition to a climate prepared, more resilient, and fair Europe.

Objectives and actions

The first objective of the mission aims by 2030 to **prepare Europe to deal with climate disruptions**. It seeks to do so by:

- Fostering a better understanding of climate risk exposure by providing accesses to fast track climate risk assessments and strengthening existing early warning systems;
- Facilitating the adoption of climate risk management and community-based emergency plans;
- Ensuring that community infrastructure is safe and essential services operable and assessable under critical conditions.

The mission also seeks to **accelerate the transition to a climate resilient future**. It has targeted support for 200 European communities and regions accelerate such a transition, and will:

- Design vision with objectives, and build consensus around transformative social change enshrined in a community resilience contract;
- Co-create adaptation pathways, and define possible courses of policy and innovation actions to deliver on the vision, resulting in a portfolio brief for action;
- Create favourable conditions for societal transformations
- Co-design and test actionable solutions, and share learning within and across the communities and regions.

A third objective of the mission is to **build deep resilience**, scaling up multiplicative actionable solutions to build resilience in a systemic approach. This involves:

- Creating impact at scale, building of resilience in single regions and communities focusing on key community systems;
- Creating cross-border value, building of resilience and shared value creation across cross-border health systems and services, cross border natural and cultural heritage, cross-border knowledge and innovation, and cross border business and value chains;
- Fostering systemic and citizen-centred co-evaluation, measuring progress made assessing what has been accomplished and communicating the progress and outcomes;

Cost

[Final Mission budget to be inserted when decision taken]

Impact pathways

In the table below impacts are assessed using a scale from (--/-/0/+/++) negative to positive. Impacts are assessed up to 2050 relative to the baseline. It assumes the full uptake of the measure as the increasing severity of physical climate risks is more widely recognised, and consequently the relevance of Europe being prepared and innovations required to build deep resilience.

Table 37: Mini-assessment on adaptation Solutions / Horizon Europe Mission on adaptation to Climate Change

Impact indicator	Relevance	Indicator	Baseline	Impact pathway	Envisaged impact 2050 (relative to baseline)
Economic					
Macroeconomic environment	Impacts on the economy are a hugely significant driver for action and reducing damages can be an important indicator of increased resilience.	Economic welfare (losses) (-/+)		Indirect impact	The Mission will seek to make important contributions to the achievement of the economic post-COVID recovery plans, including the enhancement of resilience of the economic systems, building new norms, practices, and habits that preserve the environment, and shift from a market-fixing framework to a market-shaping framework redefining the meaning of public value. **Assessment: Positive impact (+)**
Competitiveness, trade, and investment flows	Vulnerability of supply chains to impacts can be relevant and The Strategy will significantly influence the types of investments being made.	Impact on competitiveness, trade and (climate resilient) investments (+/-)		Direct impact	The mission will promote sustainable business models for income diversification, organic farming and community agriculture, sustainable and circular supply chains. All of these will improve the resilience of economic activities and decrease the vulnerability of supply chains to external shocks. Furthermore, research and innovation is to drive competitiveness in the EU by the development of innovative solutions and business models. Assessment: Positive impact(++)
Regulatory burden on business	Horizon Europe projects provide voluntary funding opportunities for firms.	Regulatory burden on business (+/-)	Minimal impact	Minimal impact	
Increased innovation and research	The Strategy will guide research under Horizon Europe and aims to encourage greater adoption of innovation.	Impact on adaptation innovation adoption (+/-)		Direct impact	The Mission employs innovation as a way to catalyse systemic change. It will embrace a model of innovation designed to test and up-scaling solutions, providing horizontal support to all partner regions by implementing **communities of practice** across the key thematic issues. As a result, by 2030, the Mission will develop **100 deep demonstrations** of climate resilience across Europe (i.e. on-the-ground examples on a large scale with verifiable impacts, and based upon citizen engagement). The 100 deep demonstrations will mostly emerge from the **living Mission Labs** that will be established by the Mission, which will function as accelerators and incubators for shared learning, crafting innovations, fostering dialogues, and maturing the regulatory frameworks needed for the implementation of emerging solutions. **Assessment: Positive impact (++)**
Public authorities	The Strategy will significantly	Public spending on	The total public spending as a	Direct	The Mission will engage all relevant actors at the local level, in the co-design, co-

(and budgets)	impact on public spending on climate resilience, primarily through indirect routes.	adaptation (€)	percentage of public spending on climate adaptation and resilience as a percentage of the city's GDP (GDPc). (Goergeson L. et al, 2016) can help provide baseline: Between 0.14 and 0.33% GDPc was allocated by cities globally in climate adaptation. 0.22% GDPc was spent by the city of Paris on adaptation and resilience in 2014/2015. growth of the spending between 2008-2015 was 4.03% [324] Moreover, according to the 2019 CoM assessment[325], 700 million EUR have been allocated to adaptation by CoM signatories.	impact	implementation, and co-evaluation of the Mission. This is expected to lead to an increase in societal ownership and have an impact on public spending on climate resilience. Besides, the Mission will support the partner regions in crowding-in and mobilising multiple forms and sources of funding and finance. To achieve this, it will assist communities in accessing the EU funds and programmes, loans from the EIB and the EBRD, as well as other national and regional funds. Therefore, it is expected that the actions by the Mission will motivate the complementary commitment for climate resilience of funds such as the European Structural and Investment Fund, the European Regional Development Fund, and the Cohesion Fund, among others. **Assessment: Positive impact (++)**
Social impacts					
Employment	Impacts on the economy and in-turn on employment are a hugely significant driver for action and reducing damages and job losses can be an important indicator of increased resilience.	Employment (FTE)		Direct impact	the Mission will support research and innovation on skills forecasting to provide information on upskilling and reskilling needs, notably through designing curricula to train on green skills, and developing community learning centres for adults. While these activities focus on education and capacity building, they ensure the work force is prepared for upcoming job opportunities in green industries Assessment: Positive impact (+)
Income distribution, social protection and social inclusion (of particular groups)	Distributional impacts of climate change can be significant, the Strategy is intended to address and mitigate inequalities, including through better informing citizens and encouraging action. Needs to address broader questions of	Distributional and equity impacts (+/-)	Based on the 2019 CoM assessment[326], public participation in adaptation planning is it makes urban adaptation more equitable and ensures the inclusion of the views of the most vulnerable communities. Nonetheless, today only 43-44% of		Two of three fundamental principles that guide the Mission are related to this impact indicator: i) the resilience of social and economic systems with a commitment to equity, social, and gender justice, and ii) the resilience of political systems, with a commitment to inclusiveness, deliberation, shared values, solidarity, and respect for diversity. By supporting the implementation of the Mission, the new Strategy will encourage the creation of enabling conditions for societal transformation, fostering community engagement, and mitigating

[324] Georgeson, L. et al (2016) "Adaptation responses to climate change differ between global megacities" Nature Climate Change 6.6 (2016): 584-588.
[325] Bertoldi, P et. Al (2020), "Covenant of Mayors: 2019 Assessment", Publications Office of the European Union, Luxembourg" ISBN 978-92-76-10722-4, doi:10.2760/775755, JRC118927
[326] Bertoldi, P et. Al (2020), "Covenant of Mayors: 2019 Assessment", Publications Office of the European Union, Luxembourg" ISBN 978-92-76-10722-4, doi:10.2760/775755, JRC118927

	equity (see other impacts) such as location, economic and social cohesion, gender and also of fundamental rights.		the signatories of the CoM report to have involved stakeholders and citizens in climate adaptation planning.		inequalities through better-informing citizens and encouraging action. **Assessment: Positive impact (++)**
Public health & safety and health systems	Increased resilience of public health and safety systems is an important goal of the Strategy.	Impact on public health and civil emergency systems (+/-)	According to the 2019 CoM Assessment, CoM signatories have reported +310 actions (including ongoing completed, not started) on the health sector, and +320 on civil protection and emergency in their climate adaptation strategies.	Direct impact	The Mission will aim to help communities to increase the resilience of their public health & safety systems by assisting with the planning and implementation of early-warning and surveillance systems. In particular, the Mission will help define and assess the resilience goals proposed under the Union Civil Protection Mechanism (UCPM) and contribute to improving the understanding of and societal preparedness for health risks. In addition, it will contribute to the EU4Health 2021-2017 programme. **Assessment: Positive impact (++)**
Environmental impacts					
The climate	Critical impact targeted by the strategy. Increase of resilience to climate impacts and preventing climate risks. In addition, potential synergies with mitigation may be worth considering.	Impact on climate resilience (+/-) *(possible) Synergy with climate mitigation (+/-)*	According to the 2019 CoM 429 signatories out of 2221 (370 from EU28+EFTA and 59 non-EU28+EFTA) have already provided information regarding their adaptation goals, risk and vulnerability assessments or action plans. This can be used as a baseline to indicate the percentage of European cities and communities implementing actions to increase climate adaptation resilience.	Direct impact	The three objectives of the Mission are expected to have a significant positive impact on improving the resilience to climate change in Europe. First, it will help citizens, communities and regions to better prepare for climate change effects by providing access to all local administrative units (LAU) and regions (NUTS) to climate risk profiles and reliable early warning systems, and support the adoption of climate risk plans, and safe social infrastructure and services. Second, it will help 200 regions and communities to articulate their visions of social change and climate-resilient pathways. Finally, it will provide deep demonstrations of climate resilience on a large scale. **Assessment: Positive impact (++)**
Quality of natural resources/fighting pollution (water, soil, air, etc.)	Strategy intends to address impacts of climate change on natural resources, e.g. forests, agriculture, marine environment.	Impact on natural resource resilience (+/-)	Some of the CoM signatories especially in EU28+EFTA municipalities have already completed the implementation of adaptation actions and reported the associated impacts on the environment. Concretely, the majority of actions (ca. 600), including all completed, on-going and planned actions, are reported to have an impact on the water sector.	Direct impact	Rethinking water management is one of the areas of research and innovation of the Mission. The aim is to foster innovations towards smart, reliable, and efficient access to water and reduced vulnerability to water-related risks. **Assessment: Positive impact (+)**
Biodiversity,	Strategy intends to address	Use of ecosystem-based	According to the 2019 CoM	Direct	Following the EU Biodiversity Strategy 2030, the Mission will boost nature-based

including flora, fauna, ecosystems and the services they provide and landscapes	impacts of climate change on biodiversity, and to make use of Ecosystem-based solutions.	solutions and increased resilience of ecosystems (+/-)	Assessment, CoM signatories have reported +270 actions (including ongoing completed, not started) on the biodiversity and environment sector, +320 on land-use planning, +290 on agriculture and forestry. This can be used as a baseline to indicate the percentage of European cities and communities implementing actions to increase climate adaptation resilience that impact biodiversity.	impact	solutions and green-blue multipurpose infrastructure investments in ecosystems. It will seek to demonstrate high performance and efficiency of nature-based solutions at large scales, and its connections between ecosystem quality and human health. **Assessment: Positive impact (++)**
Cross cutting impacts					
Impacts in developing countries	As highlighted above impacts in developing countries are important to EU economically (supply chains / markets) and socially (family ties, migration, security). Strategy aims to support improved climate resilience of 3rd (not only developing) countries.	Impact on third countries and international relations (+/-)		Minimal impact. EU Focused.	

Some key reports in the field

- European Commission (2020). A Climate Resilient Europe: Prepare Europe for climate disruptions and accelerate the transformation to a climate resilient and just Europe by 2030. Directorate-General for Research and Innovation. Available at: https://ec.europa.eu/info/publications/climate-resilient-europe_en
- European Commission (2020) Accelerating the Transition to a Climate Prepared and Resilient Europe Interim report of the Mission Board for Adaptation to Climate Change, including Societal Transformation. Directorate-General for Research and Innovation. Available at: https://op.europa.eu/en/publication-detail/-/publication/1d5234b9-b68a-11ea-bb7a-01aa75ed71a1
- European Commission (2020) Research and innovation for the European Green Deal. Topics in the Green Deal call of Horizon 2020. https://ec.europa.eu/info/research-and-innovation/strategy/european-green-deal_en#relatedlinks

- European Commission (2018) A new horizon for Europe. Impact Assessment of the 9th EU Framework Programme for Research and Innovation
- Dechezlepretre,Antoine; Fankhauser,Sam; Glachant,Matthieu Michel Marcel; Stoever,Jana; Touboul,Simon.2020. *Invention and Global Diffusion of Technologies for Climate Change Adaptation : A Patent Analysis (English).* Washington, D.C. : World Bank Group. https://documents.worldbank.org/en/publication/documents-reports/documentdetail/648341591630145546/invention-and-global-diffusion-of-technologies-for-climate-change-adaptation-a-patent-analysis

MEASURE 12.2: Develop forestry, ecosystems and agriculture decision support tools, including trees and crop suitability, weather and climate forecasts and disturbance risks.

Baseline, context and rationale

The negative impacts that climate change will have in European land ecosystems, agriculture, and forests in the coming years have been described in different reports.[327,328] Even though progress has been made, the adaptive capacity of these sectors still requires that more information will be available, including vegetation change, crop water needs, and risks of loss and extreme events, all of which will allow stakeholders to make climate-proof decisions.

In the case of forests, according to the Analytical Report on forestry[329], few databases are available addressing forest's climate vulnerability. Although some sources exist that cover multiple species at the European level, limited information is available at Member State, being current data the least available. Moreover, data about drought affecting forests, pest damage, climate related-economic damage, and vegetation change is also limited and often varies between the Member States.

Regarding agriculture, most farm managers in the EU only have practical experience (68.3 %), only less than one in ten (9.1 %) farm managers had full agricultural training, and the rest (22.6 %) had basic agricultural training.[330] In spite of this, farm owners and managers are on the frontline of adapting to climate change, and, as research has suggested, their decisions are affected by their own knowledge and beliefs.[331]

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[327] Feyen L., Ciscar J.C., Gosling S., Ibarreta D., Soria A. (editors) (2020). Climate change impacts and adaptation in Europe. JRC PESETA IV final report. EUR 30180EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-76-18123-1, doi:10.2760/171121, JRC119178.
[328] FAO and UNEP (2020). The State of the World's Forests 2020. Forests, biodiversity and people. Rome. https://doi.org/10.4060/ca8642en
[329] Forthcoming, 2021
[330] European Union (2019) Agriculture, forestry, and fishery statistics. 2019 Edition. Available at: https://ec.europa.eu/eurostat/documents/3217494/10317767/KS-FK-19-001-EN-N.pdf/742d3fd2-961e-68c1-47d0-11cf30b11489
[331] Yousefpour, R et al (2017). A framework for modeling adaptive forest management and decision making under climate change. Ecology and Society 22(4):40. https://doi.org/10.5751/ES-09614-220440

OPC: Respondents to the OPC reported that the main actions to support resilience-building in agriculture and forests are information/guidance about management practices and nature-based solutions that enhance climate resilience, information/guidance to better use existent plant/forest genetic diversity (varieties, species) to build resilience, and climate resilient land use planning. In accordance, OPC respondents also indicated that the main elements for climate resilient agriculture/forests are diversified systems (e.g. mixed farming, agro-forestry, different forest systems and management, age structure), and nature-based solutions.

Description of measure

By supporting forest owners and managers to consider climate change in their management approaches (from the choice of the species and their origin to the use of silvicultural practices and forest structure that mix species and age classes), this measure will seek to ensure that forest management practices (afforestation, reforestation, restoration) are undertaken with a view to enhance the resilience of forest ecosystems to climate impacts.

Objectives and actions:

- Strengthen ecosystems resilience by providing the farming and forestry community with ready to use information combining information on plants and tree species and varieties and their suitability in a changing climate.
- Raise awareness and accelerate action on adapting forests to climate change, by providing decision-makers with actionable information on the evolution of climate and forests.

Some of the specific proposed actions are:

- **Monitor climate impacts on natural ecosystems, agriculture and forestry**, ensuring EU-wide, consistent monitoring of disturbances and losses due to extreme events, capitalising on existing initiatives such as Forest Information System for Europe (FISE), European Forest Fire Information System (EFFIS), Copernicus land monitoring services (CLMS), Copernicus Climate Change Services (C3S).
- **Mapping projected natural vegetation changes and information about crops/trees suited to the projected climate in a particular area,** providing geographically explicit information about expected vegetation changes and suitable plants and tree species/varieties building on JRC ongoing work in this area (e.g. EcoAdapt on vulnerability and adaptation of ecosystems, Forest@risk, FORGENIUS); and integrating information about current and projected bioclimatic zones suitable for plant/tree species and varieties catalogue (with searchable options).
- **Support on-the-ground dissemination and implementation (support to value chain's actors and practitioners networks)** by helping tree nurseries to ensure that they have the right material in the right quantities to support climate-proof forest management; supporting knowledge

dissemination, piloting and implementation in the farming and forestry community; and giving visibility and facilitating information dissemination and contact matchmaking

Impact pathways

In the table below impacts are assessed using a scale from (--/-/0/+/++) negative to positive. Impacts are assessed up to 2050 relative to the baseline. It assumes the full uptake of the measure as the increasing severity of physical climate risks on Europe's natural capital is more widely recognised, and consequently the relevance of taking action on generating more data, protection, and successively making use of the adaptive capacity of ecosystems.

Table 38: Mini-assessment Measures for Land ecosystems, agriculture and forests

Impact indicator	Relevance	Indicator	Baseline	Land ecosystems, agriculture and forests	Envisaged impact 2050 (relative to baseline)
Economic					
Macroeconomic environment	Impacts on the economy are a hugely significant driver for action and reducing damages can be an important indicator of increased resilience.	Economic welfare (losses) (-/+)	Climate change affects land, agriculture, and forest-related industries such as wood processing and manufacturing. This will pose great challenges in their economic growth. In 2017, the GVA of the agriculture, forestry and fishing was EUR 220 533 million for the EU27countries[332]. For the same year, based on Division 02 of NACE Rev. 2[333] the forest industry's GVA for EU27 was EUR 26 220 million in 2017.[334] The inclusion of other activities (NACE 16; 31) by other studies estimating GVA of the forest sector, suggest that the impact on the economy of changes in land, ecosystems, agriculture, and forests could be much larger.[335]	Indirect impact	By raising awareness and accelerate action on adapting forests to climate change, this measure will help to provide decision-makers with actionable information on the evolution of climate and forests. More accurate, robust, granular, and comparable data leads to better understanding and better - informed decision making actionable information on the evolution of climate and forests.. The identification of forests that are on critical risk areas will decrease the negative macroeconomic impact of climate change by reducing the loss of these ecosystems.

[332] Eurostat. Gross value added and income by A*10 industry breakdowns (Agriculture, Forestry and Fishing)
[333] NACE Rev. 2 Statistical classification of economic activities in the European Community https://ec.europa.eu/eurostat/documents/3859598/5902521/KS-RA-07-015-EN.PDF
[334] Eurostat. Gross value added of the forestry industry, at basic prices. https://data.europa.eu/euodp/en/data/dataset/WmwTGWdwfhwPyEUUQNiCg
[335] Klauss, K. (2020) The forest sector in the Baltic States: A united, growth-oriented economic ecosystem. The forest industry around the Baltic Sea region: Future challenges and opportunities. Centrum Balticum Foundation https://eustafor.eu/uploads/BSR_Policy_Briefing_2020.pdf#page=36

					Assessment: (++)
Competitiveness, trade and investment flows	Vulnerability of supply chains to impacts can be relevant and The Strategy will significantly influence the types of investments being made.	Impact on competitiveness, trade and (climate resilient) investments (+/-)	In 2018, EU Institutions committed USD$137 million in development finance to EU countries for agriculture, forestry, fishing. The EIB committed USD$127 million for the same objective in 2018. In total, USD$477 million was committed to European development finance for agriculture, forestry, and fishing.[336] In addition, the EU's trade in agricultural goods was EUR 275 billion in 2018.During the same year, the value of trade in agricultural goods accounted for 7.0 % of total EU international trade in goods in 2018.[337]	Indirect impact	The lack of available capital for investing in improved forest management is primarily caused by the perceived high risk of forest-based investments partly due to insufficient data and suitable tools.[338] With this measure, the new Strategy will map, among others, current and projected vegetation changes and provide information about the geographic suitability of trees species, identifying areas of risks, and informing better decision-making. The actions included will not only allow us to have more precise information but also provide investors with quantitative information. **Assessment:** (+)
Regulatory burden on business	Publically provided information, data and support services will have minimal negative impacts on businesses.	Regulatory burden on business (+/-)	Minimal impact	Minimal impact	
Increased innovation and research	The Strategy will guide research under Horizon Europe and aims to encourage greater adoption of innovation.	Impact on adaptation innovation adoption (+/-)	One of the intervention areas (IAs) included in the new structure of Horizon Europe is Agriculture, Forestry and Rural Areas. This IA covers, among others, innovation and research in sustainable forest management, sustainable land use, rural development and territorial linkages, and sustainable management and efficient use of natural resources.[339]	Direct Impact	This measure aims to strengthen ecosystems resilience by providing ready to use the information to farmers and forest managers. The development of this information will require the refinement of monitoring tools, mapping systems, and significant advances in the research of species adaptability and projected vegetation changes. The required data and knowledge acquisition will be guided by the combined efforts of the private sector and research projects

[336] Stockholm Environment Institute SEI (2020). Atlas of Development Finance. Accessed 04.09.2020
[337] European Union (2019) Agriculture, forestry, and fishery statistics. 2019 Edition. Available at: https://ec.europa.eu/eurostat/documents/3217494/10317767/KS-FK-19-001-EN-N.pdf/742d3fd2-961e-68c1-47d0-11cf30b11489
[338] EIT-Climate KIC (2018) EIT Climate-KIC and the future of the forestry sector. Available at: https://www.climate-kic.org/wp-content/uploads/2018/03/Climate-KICForestryWP_FINAL-210318.pdf
[339] European Commission (2020) Agriculture in Horizon Europe. Alexia Rouby. Research and Innovation Unit European Commission DG Agriculture and Rural Development. https://bioeast.eu/wp-content/uploads/2020/03/Alexia_AgricultureInHorEU.pdf

					such as those funded under Horizon Europe. **Assessment**: (+)
Public authorities (and budgets)	The Strategy will significantly impact on public spending on climate resilience, primarily through indirect routes.	Public spending on adaptation (€)	The main EU programmes financing adaptation measures in the agriculture sector are the Member States and regional rural development programmes (RDPs) under the CAP. Under the RDPs, several adaptation measures are available and co-financed by the European Agricultural Fund for Rural Development (EAFRD). The 2014-2020 CAP consisted of three main elements: direct payments to farmers, (EUR 41.74 billion annually); market support measures, (EUR 2.7 billion annually); and rural development measures (EUR 14.37 billion annually). [340]	Direct Impact	This meassure seeks to support the climate-proof transformation of agriculture and forest ecosystems, among others, through the financial support to the adoption of preventive adaptation practices, research and innovation programs, and capacity buidling activities. **Assessment:** (++)
Social impacts					
Employment	Impacts on the economy and in-turn on employment are a hugely significant driver for action and reducing damages and job losses can be an important indicator of increased resilience.	Employment (FTE)	In total, about 535 800 persons worked in the forestry and logging sector in the EU in 2016. The largest workforces were recorded in Poland (76 700 persons employed), and then Romania (47 200 persons).[341] Moreover, 3.3 million people were employed in wood based industries, accounting for 11 % of the total employment in the manufacturing sector in 2017.[342]	Indirect Impact	By raising awareness public awareness on the need to increase climate change adaption measures on forests this measure is expected to have an indirect positive impact on the employment stability of the sector. **Assessment**: (+)
Income distribution, social protection and social inclusion (of particular groups)	Distributional impacts of climate change can be significant, the Strategy is intended to address and mitigate inequalities, including through better	Distributional and equity impacts (+/-)	Most of the farms (67%) in the EU are classified as small (<EUR 8 000 of standard output) and family-owned (96%). Climate change impacts on the agriculture and forestry sector is, therefore, expected to affect small farmers significantly.	Indirect impact	The set of actions included under this measure will support the dissemination and implementation of good practices to improve the climate resilience of the sector. This material will provide support mostly to small farmers and

[340] European Environment Agency (2019) Climate change adaptation in the agriculture sector in Europe.
Available at: https://www.euroseeds.eu/app/uploads/2019/09/Climate-change-adaptation-in-the-agriculture-sector-in-Europe.pdf
[341] European Union (2019) Agriculture, forestry, and fishery statistics. Available at: https://ec.europa.eu/eurostat/documents/3217494/10317767/KS-FK-19-001-EN-N.pdf/742d3fd2-961e-68c1-47d0-11cf30b11489
[342] Ibid.

	informing citizens and encouraging action. Needs to address broader questions of equity (see other impacts) such as location, economic and social cohesion, gender and also of fundamental rights.				vulnerable groups, which today do not have access to the right tools and data. Moreover, trustworthy data systems can help prevent small farmers from increasingly losing control and becoming overly dependent on agricultural corporations.[343] **Assessment:** (+)
Public health & safety and health systems	Increased resilience of public health and safety systems is an important goal of the Strategy.	Impact on public health and civil emergency systems (+/-)	The response of emergency systems such as the EFFIS (European Forest Fire Information System) and associated strategies rely on the availability and quality of data, for example, of wildland fires.[344] In addition, forest loss can have significant on human health. In direct terms, these impacts vary from loss of resources to the effects of forest fires; indirectly, impacts include the effects of forest clearance on, for instance, the survival and spread of disease pathogens.[345]	Direct impact	This measure of the new Strategy will capitalise on existing initiatives such as the Forest Information System for Europe (FISE), and the European Forest Fire Information System (EFFIS) to improve the monitoring of disturbances and losses due to extreme events. Moreover, knowledge dissemination across the farming and forestry community will be strengthened to promote climate-resilient forest management. As a result, it is expected that the new Strategy will have a direct positive impact on the resilience of European safety systems. In addition, improved forest management will lead to the increase of the resilience of European forests and thus of the health sector overall through the reduction of related diseases by decreasing exposure to noise and air pollution, stress, among other health benefits.[346] **Assessment**: (++)
Environmental impacts					
The climate	Critical impact targeted by the strategy. Increase of resilience to climate impacts and preventing climate risks. Also potential	Impact on climate resilience (+/-) *(possible) Synergy*	Forest owners and managers are on the frontline of adapting forest management to climate change, and, as research has suggested, their decisions are affected by their own knowledge,	Direct Impact	Climate-proof forest management will be particularly fostered by this measure through tailored support to farmers and forestry

[343] WBGU – German Advisory Council on Global Change (2019): Towards Our Common Digital Future. Flagship Report. Berlin: WBGU.
[344] EFFIS (European Forest Fire Information System) https://effis.jrc.ec.europa.eu/
[345] FERN (2005) Forest loss and human health: focus on EU policies and practices
[346] FOREST EUROPE (2019) Liaison Unit Bratislava: Human Health and Sustainable Forest Management by, Marušáková Ľ. and Sallmannshoferet M., et al. FOREST EUROPE Study

	synergies with mitigation may be worth considering.	*with climate mitigation (+/-)*	beliefs and the mapping of management options for the current and future conditions.[347]		communities that will ensure the conservation of forest area and farmland in Europe. Providing the right tools to these communities will help to raise awareness about the key role agriculture and forestry have to play in climate change action. **Assessment:** (++)
Quality of natural resources/fighting pollution (water, soil, air etc.)	Strategy intends to address impacts of climate change on natural resources, e.g. forests, agriculture, marine environment.	Impact on natural resource resilience (+/-)	In the last decades, large forest fires have occurred in Europe. The danger of forest fires will increase with unmitigated climate change in Europe, especially around the Mediterranean region, being Portugal, Spain and Turkey the three countries with the highest danger.[348]	Direct Impact	The improvement of forest management and monitoring tools will help Europe to cope with the effects of climate change on forest areas, reducing the loss of forests and associated damages to natural resources. **Assessment**: (++)
Biodiversity, including flora, fauna, ecosystems and the services they provide and landscapes	Strategy intends to address impacts of climate change on biodiversity, and also to make use of Ecosystem-based solutions.	Use of ecosystem-based solutions and increased resilience of ecosystems (+/-)	The European Red List of Trees indicates that 58 percent of the region's endemic trees are threatened, while 42 percent of all native species are threatened with regional extinction. The conservation status of these species will be much aggravated by the increase of fires and mismanagement of land.	Indirect impact	The improvement of knowledge and tools to monitoring climate impacts on natural ecosystems, agriculture, and forestry will lead to a better understanding of the effects of climate change on biodiversity. This will be achieved through the mapping of projected natural vegetation changes and suitable plants and tree species/ varieties, which can contribute to ensuring the protection of threatened species. Moreover, the dissemination of practices for climate-proof land management will raise awareness about the methods that are beneficial for the conservation of the local biodiversity. **Assessment**: (++)
Cross cutting impacts					
Impacts in developing countries	Impacts in developing countries are important to EU economically (supply chains / markets) and socially (family	Impact on third countries and international relations (+/-)		Minimal impact	

[347] Yousefpour, R et al (2017). A framework for modeling adaptive forest management and decision making under climate change. Ecology and Society 22(4):40. https://doi.org/10.5751/ES-09614-220440
[348] Feyen L., Ciscar J.C., Gosling S., Ibarreta D., Soria A. (editors) (2020). Climate change impacts and adaptation in Europe. JRC PESETA IV final report. EUR 30180EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-76-18123-1, doi:10.2760/171121, JRC119178.

	ties, migration, security). Strategy aims to support improved climate resilience of 3rd (not only developing) countries.				

Action 13: Closing the Climate Protection Gap - Macroeconomic aspects of adaptation to climate change.

MEASURE 13.1: For public finance/macro financial stability risk: introduce a step-wise approach whereby the commission engages a discussion on national disaster risk management frameworks with finance ministers' fora, underpinned by best practices and evidence from EU Member States, and further assesses impact on sustainability of public finance based on EU level scenario analysis and stress testing. This would lay the ground for mainstreaming climate change in the national fiscal processes.

Baseline, context and Rationale

The measure would help inform the fiscal surveillance frameworks (EU and national). Expected economic losses related to climate change have the potential to have increasingly large implications on fiscal stability and sustainability of the EU Member States. In the absence of financial protection tools for coping with disasters, the incidence of major disasters in several EU Member States may exacerbate economic imbalances and deteriorate credit ratings.

Description of Measure

Break national level silos between climate policy, disaster risk management and fiscal and budgetary processes; Incentivize Member States to consider and develop risk-sharing solutions; trigger climate protection gap discussion with Member States and consider inclusion of the fiscal aspects of disaster risk management in national budgetary framework

Objectives and Actions

- **Research:** Development of a model to estimate the loss distribution for the EU insurance sector, by country, in relation to the occurrence of extreme natural events and quantify the funding cost to cope with the estimated catastrophic risk.
- Support Member States to strengthen the national risk assessments under the Union Civil Protection Mechanism, notably by including quantitative and qualitative assessments of all physical risks and complex compound risks for various scenarios (including climate change), that contribute to robust Disaster Risk Management (DRM) planning and better meet the needs for public sector financial risk management. This action starts with a thorough evaluation of current risk assessment methods and practices, legal reporting requirements and practices. Assess the potential impact on public debt sustainability due to the improvement in resilience to climate risks through adaptation through scenario analysis;
- Articulate the DRM and disaster risk financing (DRF) strategy with the national budgetary process to include ;

- Quantitative assessments of fiscal implications by type of risk (including climate change) and all possible measures that could be used to address the risks.
- Information on the DRF strategy over the medium term – source of public funds available for the various DRM phases (risk assessment, prevention and preparedness, response and recovery); the rules to establish and access such funds and the governance arrangements; Details on "who pays for what" at national, regional and local level in *ex ante* (prevention and preparedness) and the expected share and conditions of government participation in ex-post disaster financial compensation or if not available, information on the risk sharing arrangements between stakeholders;

Impact pathways

In the table below impacts are assessed using a scale from (--/-/0/+/++) negative to positive. Impacts are assessed up to 2050 relative to the baseline.

Table 39: Mini-assessment on closing the climate protection gap

Impact indicator	Relevance	Indicator	Baseline	Impact pathway	Envisaged impact 2050 (relative to baseline)
Economic					
Macroeconomic environment	Impacts on the economy are a hugely significant driver for action and reducing damages can be an important indicator of increased resilience.	Economic welfare (losses) (-/+)	The diverse and the pervasive impacts of a changing climate cut across all kinds of human activity. **Without** a multi-sectoral and cross-cutting approach to mainstreaming climate-related financial risk management, climate impacts will burden Member State economies with a clear North to South divide.	Indirect Impact	Insurance and climate-resilient debt instruments that are designed to mitigate the fiscal impact of climate-related events and reduce fiscal sustainability risks can be implemented. The use of these financial instrument can be supported by including fiscal aspects of disaster risk management in national budgetary frameworks, .broader insurance against climate-related risks would secure the macroeconomic environment by reducing risks to damage, and allocating funding to deal with the consequences of disasters when they do arrive. Improved disaster isk management frameworks to imrpvoe the knowledge base on physical risks to improve the macro-economic envirnment. **Assessment:** Positive impact (+)
Competitiveness, trade and	Vulnerability of supply chains to	Impact on	Delivery of essential services will be	Indirect Impact	The broader use of insurance and other financial

investment flows	impacts can be relevant and The Strategy will significantly influence the types of investments being made.	competitiveness, trade and (climate resilient) investments (+/-)	severely impacted. Infrastructure and assets in hazardous areas will be susceptible to impact, and may not have appropriate insurance coverage of their risks. Just-in-time supply, few alternative sources/routes/suppliers, dependence on imports can further exacerbate the negative impacts of natural disasters.		risk mitigation techniques will incentivise making supply chains more resilient and reduce vulnerability to economic hardship after climate events.**Assessment:** Positive impact (+)
Regulatory burden on business	Measure targets actions by EU institutions and national authorities, minimal impact for business.	Regulatory burden on business (+/-)	Minimal impact	Minimal impact	
Increased innovation and research	The Strategy will guide research under Horizon Europe, and aims to encourage greater adoption of innovation.	Impact on adaptation innovation adoption (+/-)	Current models are based on incomplete historical data, and are not reliable/forward looking enough to properly identify vulnerable regions and critical infrastructure.	Direct impact	Development of a model to estimate the loss distribution for the EU insurance sector, by country, in relation to the occurrence of extreme natural events and to quantify the funding needs necessary to cope with the estimated catastrophic risk. Gathering qualitiative and quantitative information comparable across Member States will also improve existing and future models. **Assessment:** Positive impact (+)
Public authorities (and budgets)	The Strategy will significantly impact on public spending on climate resilience, primarily through indirect routes.	Public spending on adaptation (€)	Climate-related risk is not considered throughout all decision-making processes, and there lacks allocation of clear responsibilities and climate risk-ownership. Insurance penetration remains low in several Member States, and residual risk financial risk management is scarce.	Direct Impact	Measure the potential impact on public budgets and public debt sustainability due to the improvement in resilience to climate risks through adaptation. Incentives to Member States to develop risk-sharing solutions will mitigate the impacts of disasters on public spending on disasters. Dedicating upfront resources to prevention and preparedness and to deal with the immediate consequences of climate-related events reduces the burden on States in the recovery phase. Using financial instruments rather than grants for productive investments could crowd-in private finance and would reduce the burden on the state during prevention and recovery. Improved disaster isk management frameworks to imrpvoe the knowledge base on physical risks

					to improve the macro-economic envirnment. **Assessment:** Positive impact (+)
Social impacts					
Employment	Impacts on the economy and in-turn on employment are a hugely significant driver for action and reducing damages and job losses can be an important indicator of increased resilience.	Employment (FTE)	The importance of business continuity is not included in natural disaster risk managements efforts, and the high level of dependency on system interconnectedness negatively impacts employment across sectors after a natural disaster.	Indirect Impact	Broad climate proofing measures to reduce risks to the economy and in turn employment. Ensure that SMEs have appropriate insurance coverage for their particular vulnerabilities, by assessing vulnerable hotspots and increasing the insurance penetration rate. **Assessment:** Positive impact (+)
Income distribution, social protection and social inclusion (of particular groups)	Distributional impacts of climate change can be significant, the Strategy is intended to address and mitigate inequalities, including through better informing citizens and encouraging action. Needs to address broader questions of equity (see other impacts) such as location, economic and social cohesion, gender and also of fundamental rights.	Distributional and equity impacts (+/-)	Low socio-economic tolerance for loss and disruption. Sections of the population and the economy that do not have access to reasonably priced coverage.	Direct Impact	Detailed geographic analyses at the regional level will aid in identifying where vulnerability to climate hazards overlap with socio-economic vulnerabilities and allow authorities to increase the resilience of these groups. A key aspect of this is exploring "just resilience" to provide an accurate account of current and emerging inequalities in exposure, impacts, and underinsurance aspects. This will lead to higher penetration rates of insurance to protect these vulnerable groups. **Assessment:** Positive impact (+)
Public health & safety and health systems	Increased resilience of public health and safety systems is an important goal of the Strategy.	Impact on public health and civil emergency systems (+/-)	Risk-related literacy issues and risk related understanding of public health. A lack of awareness leads to reduced resilience of public systems in regard to risk transfer. Public-private sector cooperation remains low.	Direct Impact	Public authorities consider actions to narrow the insurance protection gap and increase resilience of public health. Identification of country-relevant risks and types of desired coverage will aid in closing the protection gap. **Assessment:** Positive impact (+)
Environmental impacts					
The climate	Critical impact targeted by the strategy. Increase of resilience to climate impacts and preventing climate risks. Also potential synergies with mitigation may be worth considering.	Impact on climate resilience (+/-) *(possible) Synergy with climate mitigation (+/-)*	Society bears the full weight of climate-related impacts, without appropriate risk transfer solutions. There will be severe disruptions to daily life and recovery from impacts will take longer and be more arduous.	Direct Impact	Strengthened National Risk Assessments (NRAs) under the Union Civil Protection Mechanism to include quantitative and qualitative assessments of all physical risks and complex compound risks for different scenarios will, among other things, better correspond to the needs of macro-economic analysis and increase the resilience of

					socieites to the impact of climate change. **Assessment:** Positive impact (+)
Quality of natural resources/fighting pollution (water, soil, air etc.)	Strategy intends to address impacts of climate change on natural resources, e.g. forests, agriculture, marine environment.	Impact on natural resource resilience (+/-)		Minimal Impact	
Biodiversity, including flora, fauna, ecosystems and the services they provide and landscapes	Strategy intends to address impacts of climate change on biodiversity, and also to make use of Ecosystem-based solutions.	Use of NbS and increased resilience of ecosystems (+/-)		Minimal Impact	
Cross cutting impacts					
Impacts in developing countries	As highlighted above impacts in developing countries are important to EU economically (supply chains / markets) and socially (family ties, migration, security). Strategy aims to support improved climate resilience of 3rd (not only developing) countries.	Impact on third countries and international relations (+/-)		Minimal Impact	

ACTION 14: Ensuring the availability of fresh water.

MEASURE 14.1: Continue to use the Common Implementation Strategy to improve policy implementation for securing sustainable water use across sectors, through improvements to and intensification of among others: water resource allocation, water-permitting systems, cost recovery through water pricing incorporating externalities, or cost recovery rate calculations.

Baseline, context and rationale

To achieve sustainable protection and use of water resources, which will become even more important due to climate change, it is particularly relevant to ensure the security of supply for citizens, and a balanced and coherent approach to the sometimes competing uses of water by different sectors. Energy and agriculture are particularly pertinent in this respect and may clash with environmental protection. For example, wasteful/excessive water use in agriculture is a challenge for both water (and its alternative uses) and food security. Water reuse and efficient and sustainable irrigation can help reduce the agricultural water footprint and bring environmental and societal benefits only provided they are implemented in a sustainable system,

where environmental water flows are ensured. It will also be necessary to consider how further integration of water legislation with other policy areas can best be advanced in a mutually supportive way; this is especially important in view of the emerging challenges for water management caused by climate change and pollutants of emerging concern.

Interviews: One expert interviewed for this study thought that binding targets in the EU Adaptation Strategy should be linked to other policies (e.g. Water Framework Directive). Several experts expressed that water scarcity problems are not just problems in the South, but in all of Europe, and that Southern Member States have relevant knowledge on managing water scarcity that can be shared with Northern Member States.

OPC: Over half of respondents to the OPC reported experiencing restrictions on water availability due to prolonged drought in their place of residence due to climate change (54%), even more reported experiencing river and coastal floods (65%). Furthermore, the majority of respondents strongly agreed that further action for sustainable adaptation to climate change is needed within the new Strategy for the water sector (75%).

Objectives and actions:

Further support implementation of the relevant existing CIS Guidance documents (e.g. CIS Guidance on water balances, environmental flows, etc.), revise or develop new guidelines and share good practice under CIS for sustainable use of water resources across sectors (including ensuring environmental flows) based on Commission's own analysis and other existing studies (including OECD work), explore the best policy mix of improvements to and intensification of, among others:

- Water resource allocation. (in particular, water should not be monopolised by particular sectors, e.g. through the use of grey infrastructure like water reservoirs, which can be observed in some regions).
- Water permitting systems
- Cost recovery through water pricing, incorporating externalities
- Cost recovery rate calculations according to Art 9 of the WFD[349].

Impact pathways

[349] A CIS Ad hoc Task Group on economics has recently been set up in the area of financing of measures under the WFD and the FD; in addition, two ongoing studies are relevant (1) on a mapping of economic data (including how cost recovery is applied in Member States), this will also serve as a building block for (2) a study with the OECD on investment needs (specifically for the WFD and the FD), which will start 2nd half of 2020.

In the table below impacts are assessed using a scale from (--/-/0/+/++) negative to positive. Impacts are assessed up to 2050 relative to the baseline. It assumes the full uptake of the measure as the increasing severity of physical climate risks on Europe's water resources is more widely recognised. Consequently, the implementation in legislative actions ensures its impact.

Table 40: Mini-assessment on Common Implementation Strategy

Impact indicator	Relevance	Indicator	Baseline	Impact pathway	Envisaged impact 2050 (relative to baseline)
Economic					
Macroeconomic environment	Impacts on the economy are a hugely significant driver for action and reducing damages can be an important indicator of increased resilience.	Economic welfare (losses) (-/+)	Minimal impact. CIS is not used, and water policy implementation gap remains. Certain sectors dominate consumption, and water quantity and quality issues continue to burden Member States.	Indirect impact – economic benefits and costs of cost recovery through water pricing.	Quantitative impacts included as part of Option 2 assessment in chapter 6. This measur improves the water availability and lowers the effects from droughts to a respective extent. Since the damages increase with temperature (Adapted from Iglesias et al., 2012 and Ciscar et al., 2011), the decrease is held constant at 10% across scenarios. The costs comprise a shift in demand from water to machinery costs. Resulting in reduced economic losses. **Assessment:** Quantitative results included in Option 2, chapter 6. Qualitative assessment: (+)
Competitiveness, trade and investment flows	Vulnerability of supply chains to impacts can be relevant and The Strategy will significantly influence the types of investments being made.	Impact on competitiveness, trade and (climate resilient) investments (+/-)	Wasteful/excessive water use in agriculture challenges food security with increased droughts. Impacts on inland shipping and hydropower.	Direct impact	Fair water pricing levels the playing field for industries that are reliant on freshwater. Sectors such as agriculture, energy, processing, manufacturing, transport, and households are likely to face higher water costs, or restrictions to water availability. **Assessment:** (-)
Regulatory burden on business	Direct impact on water sector firms (mix of public and private firms), indirect impacts on those affected by changed in water pricing.	Regulatory burden on business (+/-)	Firms active in water sector struggle to recover costs, unless able to charge consumers more / underinvest in infrastructure. Large water users continue to enjoy below cost access to water, leading to inefficient water use and exacerbated impacts in drought conditions.	Direct and indirect impacts	Changes to water pricing would typically benefit water sector businesses as income would increase and a greater part of costs could be covered. But across the wider economy businesses, particularly water intensive industries such as agriculture and food and drink manufacture would likely face increase costs, potentially significant increases, depending on how implemented. **Assessment:** (-)
Increased innovation and research	The Strategy will guide research under Horizon Europe, and aims to encourage greater adoption of innovation.	Impact on adaptation innovation adoption (+/-)	Minimal	Minimal / indirect impact	
Public authorities (and	The Strategy will significantly impact on public spending on	Public spending	Member States and stakeholders are not implementing policy to adequately	Direct impact	Financing of measures under the Water Framework Directive, as well as addressing investment needs to extend and intensify cost recovery through

budgets)	climate resilience, primarily through indirect routes.	on adaptation (€)	address water security issues. There is not enough support for water resource allocation and management plans. Cost recovery incorporating environmental and resource costs is not widely done across Member States, and what actions is being taken isn't transparent or using a harmonised methodology.		water pricing. **Assessment**: (+)
Social impacts					
Employment	Impacts on the economy and in-turn on employment are a hugely significant driver for action and reducing damages and job losses can be an important indicator of increased resilience.	Employment (FTE)		Minimal impact	Included in modelling results for Option 2 in chapter 6
Income distribution, social protection and social inclusion (of particular groups)	Distributional impacts of climate change can be significant, the Strategy is intended to address and mitigate inequalities, including through better informing citizens and encouraging action. Needs to address broader questions of equity (see other impacts) such as location, economic and social cohesion, gender and also of fundamental rights.	Distributional and equity impacts (+/-)	Water flows affect food security, and scarcity could lead to increased food prices as well as less water available to marginalized groups. Less water available for human use.	Indirect impact	Water is a basic need, and securing water across sectors ensures the continued access to freshwater for all EU Citizens, especially those most vulnerable to the water related impacts of climate change. **Assessment:** (+)
Public health & safety and health systems	Increased resilience of public health and safety systems is an important goal of the Strategy.	Impact on public health and civil emergency systems (+/-)	Water quality and quantity is not ensured for public use in future scenarios.	Targeted direct impact.	Climate change is projected to exacerbate droughts, intensify flooding, overflow urban drainage systems, increase saltwater intrusion and sea level rise, and change water quality conditions by increasing temperatures in sources and pipelines. Additionally, urbanisation likely to augment water demand issues with stress in urbanised areas and overcapacity in rural regions. Future water supplies reliant on surface and ground water will be impacted. Improving policy implementation supports water supply managers in critical regions, ensuring access to water for human use.

					Assessment: (+)
Environmental impacts					
The climate	Critical impact targeted by the strategy. Increase of resilience to climate impacts and preventing climate risks. Also potential synergies with mitigation may be worth considering.	Impact on climate resilience (+/-) *(possible) Synergy with climate mitigation (+/-)*	The latest projections suggest that the current level of implementation may not be sufficient to prevent and manage the ongoing impacts of the climate crisis.	Direct Impact	Increase resilience of Member States to climate impacts on water quantity, by adapting sectors to increasing supply pressures. **Assessment:** (++)
Quality of natural resources/fighting pollution (water, soil, air etc.)	Strategy intends to address impacts of climate change on natural resources, e.g. forests, agriculture, marine environment.	Impact on natural resource resilience (+/-)	EU faces water scarcity and water quality issues, as sectors reliant on heavy water use (agriculture, energy) continue to use water at an excessive rate, there will be less water available for non-human use. Competition for water as a natural resource.	Direct Impact	Reduces the competition for water between industry and environmental protection. Wasteful and excessive water use is challenged, and sectors adapt to become use water more efficiently. **Assessment:** (+)
Biodiversity, including flora, fauna, ecosystems and the services they provide and landscapes	Strategy intends to address impacts of climate change on biodiversity, and also to make use of Ecosystem-based solutions.	Use of ecosystem-based solutions and increased resilience of ecosystems (+/-)	Less water available to ecosystems.	Direct Impact	Environmental water flows are ensured, and externalities are incorporated into water pricing. **Assessment:** (+)
Cross cutting impacts					
Impacts in developing countries	As highlighted above impacts in developing countries are important to EU economically (supply chains / markets) and socially (family ties, migration, security). Strategy aims to support improved climate resilience of 3rd (not only developing) countries.	Impact on third countries and international relations (+/-)	No impact, is EU focused	No impact, is EU focused	

MEASURE 14.3: Reduce exposure to contaminated or acutely polluted water due to climate impacts such as low flows, higher water temperature or flooding, and also to ensure availability of adequate quantities of tap water

Baseline, context and rationale

Climate change leads to a higher frequency and intensity of water quantity-related extreme events, namely floods and droughts. Preparation for such events requires other types of actions than preparing for gradual changes, starting from better predicting their occurrence through planning preparedness measures all the way to upgrading relevant infrastructure, such as inland navigation.

There are also significant health concerns over predicted changes in both water quantity and quality as climate change is projected to shrink water resources, reduce self-purification capacity of freshwater basins (warmer water has less dissolved oxygen and decreased flows fewer dilution capacity), increase risks of water pollution and pathogen contamination in many parts of Europe (floods, sewer overflows, more pesticide use, higher concentration of pollutants during periods of drought - e.g. the rise of Vibriosis infections in the Baltic Sea area). Thus, there are important water safety vulnerabilities, which translate into growing human health risks. For these reasons, the WHO 'Health in Climate' working group considers water safety a matter of high priority. The notion of water safety could be extended to quantitative issues with drinking water, as not all Member States have clear strategies in place to secure that their water suppliers take actions to prevent disruptions in water supply. Under the revised Drinking Water Directive, however, Member States are required to carry out hazard and risk assessments on water quality (which can be impacted by water quantity as explained above) also with a view on climate change impacts.

Interviews: One expert interviewed for this study thought that binding targets in the EU Adaptation Strategy should be linked to other policies (e.g. Water Framework Directive). Several experts expressed that water scarcity problems are not just problems in the South, but in all of Europe, and that Southern Member States have relevant knowledge on managing water scarcity that can be shared with Northern Member States.

OPC: Over half of respondents to the OPC reported experiencing restrictions on water availability due to prolonged drought in their place of residence due to climate change (54%), even more reported experiencing river and coastal floods (65%). Furthermore, the majority of respondents strongly agreed that further action for sustainable adaptation to climate change is needed within the new Strategy for the water sector (75%).

Description of measure

Objectives and actions

- Ensure that short term acute water pollution and contamination issues for situations that could arise from climate change impacts are taken into account under the new risk based approach under Article 7 of the revised Drinking Water Directive.
- Consider the exploration of further integrating climate change impacts into already established framework plans, as well as WHO's Water Safety Plans and Sanitation Safety Plans, including quantitative aspects, especially once first implementation results from the new Drinking Water Directive are available and as part of the revision of the Urban Waste Water Treatment Directive.

Impact pathways

In the table below impacts are assessed using a scale from (--/-/0/+/++) negative to positive. Impacts are assessed up to 2050 relative to the baseline.

The table below highlights the main impact pathways targeted or expected. It is primarily an information tool that hopes to address weaknesses in understanding and knowledge of vulnerabilities, risks and solutions and in doing so lead to better-informed decision making by actors across sectors. This is also aimed to (indirectly) spur action by Member States, specific economic sectors in order to increase resilience and reduce impacts for vulnerable groups.

Table 41:Mini-assessment on Promoting the inclusion of climate aspects in already established framework plans, including in Water Safety Plans

Impact indicator	Relevance	Indicator	Baseline	Water impact pathway	Envisaged impact 2050 (relative to baseline)
Economic					
Macroeconomic environment	Impacts on the economy are a hugely significant driver for action and reducing damages can be an important indicator of increased resilience.	Economic welfare (losses) (-/+)	The economy faces risks to water quality and quantity and a secure supply of potable water.	Indirect impact	Water Safety plans covering also quantitative issues and other water quality guidance ensure the safety of a drinking water supply and benefit SMEs and industry. **Assessment:** (+)
Competitiveness, trade and investment flows	Vulnerability of supply chains to impacts can be relevant and The Strategy will significantly influence the types of investments being made.	Impact on competitiveness, trade and (climate resilient) investments (+/-)	Impact on industries reliant on safe drinking water.	Indirect impact	Cleaner water and higher availability and resilience will benefit sectors, but may come at risk of higher costs. **Assessment:** (0)
Regulatory burden on business	Improvements to water cleanliness and availability will benefit firms. The costs for implementing plans are likely to	Regulatory burden on business (+/-)	Minimal impact.	Indirect impact	Improvements to plans may lead to additional health and safety requirements for firms in the water sector and major water

	mostly, but not entirely, fall upon public authorities. Private businesses can be expected to face some new safety requirements.				users. Main costs likely to be public. **Assessment:** (-/0)
Increased innovation and research	The Strategy will guide research under Horizon Europe, and hopes to encourage greater adoption of innovation.	Impact on adaptation innovation adoption (+/-)	Minimal / indirect impact?	Minimal / indirect impact	
Public authorities (and budgets)	The Strategy will significantly impact on public spending on climate resilience, primarily through indirect routes.	Public spending on adaptation (€)	Not all Member States have clear strategies in place to secure their water supply.	Direct impact	Public authorities publish water quality/quantity guidance, and establish monitoring and control measures for Water Safety plans, and implement well the revised DWD. **Assessment:** (+)
Social impacts					
Employment	Impacts on the economy and in-turn on employment are a hugely significant driver for action and reducing damages and job losses can be an important indicator of increased resilience.	Employment (FTE)		Minimal impact	
Income distribution, social protection and social inclusion (of particular groups)	Distributional impacts of climate change can be significant, the Strategy is intended to address and mitigate inequalities, including through better informing citizens and encouraging action. Needs to address broader questions of equity (see other impacts) such as location, economic and social cohesion, gender and also of fundamental rights.	Distributional and equity impacts (+/-)	Safe drinking water by tap helps vulnerable populations, who may not have access to filtered water sources.	Direct impact	A stable and secure supply of drinking water is guaranteed for all of society, including those most vulnerable. **Assessment**: (+)
Public health & safety and health systems	Increased resilience of public health and safety systems is an important goal of the Strategy.	Impact on public health and civil emergency systems (+/-)	And incongruent rollout of Water Safety Plans, means that not all Member States are adequately prepared for the health challenges connected to climate impacts on water.	Targeted direct impact.	Climate impacts are incorporated into Water Safety Plans increasing water security and safeguarding public health, and are considered as part of the risk assessment carried out under the revised DWD. **Assessment:** (+)
Environmental impacts					

The climate	Critical impact targeted by the strategy. Increase of resilience to climate impacts and preventing climate risks. Also potential synergies with mitigation may be worth considering.	Impact on climate resilience (+/-) *(possible) Synergy with climate mitigation (+/-)*	Climate change will require rapid response to events that cause an immediate threat to water quality[350] and quantity.	Targeted indirect impact.	Increased resilience to impacts of climate change by reducing exposure through implementation of clear water supply strategies. **Assessment:** (+)
Quality of natural resources/fighting pollution (water, soil, air etc.)	Strategy intends to address impacts of climate change on natural resources, e.g. forests, agriculture, marine environment.	Impact on natural resource resilience (+/-)	Water quality continues to degrade under increased temperatures, infrastructure leakages, flooding, and exposure to contaminants.	Targeted indirect impact.	Water quality is protected by reducing exposure to contaminated/polluted water due to climate impacts. **Assessment:** (+)
Biodiversity, including flora, fauna, ecosystems and the services they provide and landscapes	Strategy intends to address impacts of climate change on biodiversity, and also to make use of Ecosystem-based solutions.	Use of ecosystem-based solutions and increased resilience of ecosystems (+/-)	Ecosystems will face drought, flooding, and pollution, negatively impacting the biodiversity they contain.	Targeted indirect impact.	Climate impacts are incorporated into water quality and quantity governance, improving ecosystem health which is also dependent on clean and continuous water flows. Additionally, ecosystem service can be explored to increase water quality, and prevent evaporation/desertification. **Assessment:** (+)
Cross cutting impacts					
Impacts in developing countries	As highlighted above impacts in developing countries are important to EU economically (supply chains / markets) and socially (family ties, migration, security). Strategy hopes to support improved climate resilience of 3rd (not only developing) countries.	Impact on third countries and international relations (+/-)	No impact, is EU focused	No impact, is EU focused	

Some key reports in the field

[350] Mesquita, E., João, M. R., Menaia, J., Kardinaal, E., Eikebrokk, B., & Smeets, P. (2013). Adapted operation of drinking water systems to cope with climate change. 103. http://www.prepared-fp7.eu/viewer/file.aspx?FileInfoID=369

- CIS Guidance document No. 24 (2009). River basin management in a changing climate. https://circabc.europa.eu/sd/a/a88369ef-df4d-43b1-8c8c-306ac7c2d6e1/Guidance%20document%20n%2024%20-%20River%20Basin%20Management%20in%20a%20Changing%20Climate_FINAL.pdf
- European Environment Agency (2020). Use of freshwater resources in Europe (incl. Water exploitation index plus (WEI+) for river basin districts) https://www.eea.europa.eu/ds_resolveuid/IND-11-en
- Mesquita, E., João, M. R., Menaia, J., Kardinaal, E., Eikebrokk, B., & Smeets, P. (2013). *Adapted operation of drinking water systems to cope with climate change*. 103. http://www.prepared-fp7.eu/viewer/file.aspx?FileInfoID=369
- Rosén, L., Hokstad, P., Lindhe, A., & Sklet, S. (2007). Generic Framework and Methods for Integrated Risk Management in Water Safety Plans. *Techneau*, *June*, 107.
- Rustler, M., Grützmacher, G., Meseguer, J., Cembrano, G., & Escaler, I. (2012). *Decision Support Systems for water resource planning under climate change conditions Conceptual framework*.

Annex 8: Legal basis for EU action in climate change adaptation

Table 42: Legal instruments in suport of EU action in climate change adaptation

Legal basis	Legal instruments	Mandate for the EU to act	Commentary
EU legal instruments	Treaty on the Functioning of the European Union (TFEU)[351]	Articles 191 and 192(1) TFEU	In accordance with Articles 191 and 192(1) TFEU, the **European Union shall contribute to the pursuit, inter alia, of the following objectives: preserving, protecting and improving the quality of the environment, promoting measures at international level to deal with regional or worldwide environmental problems, and in particular combating climate change.**
		Article 212 on Economic, Financial and Technical Cooperation with Third Countries.	Giving legal basis for more ambitious international cooperation objective under the new strategy. **Spillover effects of climate change and trade relationships with third countries makes international action in climate change adaptation "consistent with the development policy of the Union"** as stipulated in the article.
International legal instruments	Paris Agreement	Article 7.1	Parties hereby **establish the global goal on adaptation of enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change**, with a view to contributing to sustainable development and ensuring an adequate adaptation response in the context of the temperature goal referred to in Article 2.
		Article 7.7	Parties **should strengthen their cooperation on enhancing action on adaptation**, taking into account the Cancun Adaptation Framework.
		Article 7.9	Each Party **shall, as appropriate, engage in adaptation planning processes and the implementation of actions**, including the development or enhancement of relevant plans, policies and/or contributions.
		Article 7.10 and 7.11	Each Party **should submit and update periodically an adaptation communication,** which may include information on its priorities, implementation and support needs, plans and actions.
		Article 13.7 and 13.14	According to the transparency framework, all **parties should provide information related to climate change impacts and adaptation under Article 7**, as appropriate. **Support shall be provided to developing countries for the implementation of this Article.**
	United Nations Framework Convention on Climate Change	Decision 9/CMA.1 of the Conference of the Parties[352]	The Conference of the Parties serving as the meeting of the Parties to the Paris Agreement, recalling relevant provisions of the Convention and the Paris Agreement, in particular Article 7, notes that th**e purpose of the adaptation communication is to:** (a) **Increase the visibility and profile of adaptation** and its balance with mitigation; (b) **Strengthen adaptation action and support for developing countries**; (c) Provide **input to the global stocktake**; (d) Enhance **learning and understanding of adaptation needs and actions**

[351] European Council (2012) Consolidated version of the Treaty on the Functioning of the European Union, 2012/C 326/01, available at - https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A12012E%2FTXT

[352] UNFCC (2019) Report of the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement on the Third part of its first session, held in Katowice, FCCC/PA/CMA/2018/3/Add.1, available at – https://unfccc.int/sites/default/files/resource/cma2018_03a01E.pdf.
Further details on adaptation communication and its elements are available: https://unfccc.int/sites/default/files/resource/cma2018_03a01E.pdf

Annex 9: Climate change and its impacts

Climate change is already occurring and its impacts felt across the world. Europe has warmed faster than any other continent over recent decades with European temperature almost 2°C above temperatures of the latter half of the 19th century[353], with impacts and adaptation needs that we are feeling already now and that are expected to grow.

The past five years were the warmest on record[354], with global average temperature reaching 1.1°C above pre-industrial levels in 2019. Human-induced global warming is presently increasing at a rate of 0.2°C per decade[355]. However, temperature increase is not the same everywhere. Regions for example the Arctic regions are warming faster and if current trends continue, there is a risk for cascading tipping points.

The effects of rising temperatures and greenhouse gas emissions are being felt in Europe and around the world. Heatwaves were the deadliest meteorological hazard in the 2015–2019 period[356] and are becoming more intense in Europe. In summer 2019 they led to more deaths than the seasonal average in parts of Europe as temperatures broke records in several countries, including a new record of over 34°C above the Arctic Circle. In Europe almost all years since 2000 show above-average fire danger, with a number of associated disastrous events in the recent past, such as Pedrógão Grande wildfires (Portugal) in 2017, wildfires in Attica (Greece) in 2018 with 102 lost human lives, and the Scandinavian fire season in 2018.

There is a strong possibility that global warming will reach and overshoot 1.5°C, at least temporarily, before temperatures can be reduced again, raising the question of what it means for warming to cross the global 1.5°C threshold, and how impacts and the adaptation challenge in Europe will evolve. In examining these issues, this section builds upon section 5.9 of the in-depth analysis in support of the Commission Communication on the EU long term strategy[357] and updates findings since 2018.

1. Global impacts due to climate change

The recent reports of the IPCC[358] find that robust differences in climate characteristics are projected between the present-day and global warming of 1.5°C, and between 1.5°C and 2°C. The main differences in impacts between these warming levels are examined systematically in SR1.5. Further detail is provided in the subsequent IPCC reports on climate change and land (SRCCL) and on ocean and cryosphere in a changing climate (SROCC). SRCCL finds that risks associated with permafrost degradation, wildfire, coastal degradation and stability of

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[353] Copernicus Climate Change Service (2019). European State of the Climate, 2019. https://climate.copernicus.eu/ESOTC/2019/surface-temperature
Note that land has warmed more rapidly than the ocean. Therefore, most populated regions of the world have experienced warming above the global average. However, Europe has warmed more than other regions.

[354] WMO Statement on the State of the Climate in 2019

[355] IPCC Special Report on Global Warming of 1.5°C (2018). Section 1.1

[356] United in Science (2019), High-level synthesis report of latest climate science information convened by the Science Advisory Group of the UN Climate Action Summit 2019. https://public.wmo.int/en/resources/united_in_science

[357] https://ec.europa.eu/clima/sites/clima/files/docs/pages/com_2018_733_analysis_in_support_en_0.pdf

[358] Special Report on Global Warming of 1.5°C – SR15 (2018), Special Report on Climate Change and Land – SRCCL (2019) and Special Report on Ocean and Cryosphere in a Changing Climate – SROCC (2019)

food systems are high at 1.5°C, while risks associated with soil erosion, vegetation loss, and change in nutrition become high at higher temperature thresholds due to increased possibility for adaptation. SROCC focuses largely on differences in impacts between a below 2°C scenario and a high emissions scenario[359] and shows that keeping warming below 2°C will lead to multi-metre differences in sea-level rise beyond 2100. Limiting warming will also slow ice loss and reduce impacts on the ocean (such as marine heatwaves and acidification due to the ocean's absorption of CO_2) which in turn harm marine life and fisheries. Limiting warming to 1.5°C therefore increases the chances of ecosystem-based adaptation measures (such as wetland preservation and restoration) proving effective.

On the issue of Earth system tipping points, such as slowdown of the Atlantic Meridional Overturning Circulation (Gulf Stream) or instability of the Greenland and West Antarctic ice sheets, SR1.5 finds greater risks at lower temperatures compared to the previous (fifth) assessment report of IPCC, with moderate risk at 1°C of warming and high risk at 2.5°C of warming. While the IPCC does not explicitly label global warming of 1.5°C as an Earth system tipping point, there is abundant evidence that impacts and risks are greater at higher temperatures (every tenth of a degree matters). For example, articles such as Lenton et al. (2019)[360] make a precautionary case for keeping global warming as low as possible on the basis that while low probability, high impact events are little understood, science has progressively assessed them as being more likely at lower temperatures as knowledge has improved.

The Council conclusions on Climate Diplomacy[361] underline that climate change multiplies threats to international stability and security in particular affecting those in most fragile and vulnerable situations, reinforcing environmental pressures and disaster risk, contributing to the loss of livelihoods and forcing the displacement of people.

[359] These are scenarios RCP2.6 and RCP8.5 respectively. Warming under RCP8.5 is widely considered to be greater than current business-as-usual scenarios.
[360] Lenton, M., et al. (2019). Climate tipping points — too risky to bet against. Nature | Vol 575 | 28 November 2019.
[361] Council conclusions on Climate Diplomacy, ST-5033-2020 of 20 January 2020, https://data.consilium.europa.eu/doc/document/ST-5033-2020-INIT/en/pdf

Table 43: Selected Climate Change Impacts to Natural Systems at 1.5°C & 2°C warming

	At 2°C	At 1.5°C
Extreme hot days	4°C hotter	3°C hotter
Sea level rise by 2100	around 0.1m more than at 1.5°C (less time to adapt)	0.26-0.77m
Ecosystems	13% of global land area changes from one ecosystem type to another	area at risk ~50% lower than at 2°C
Habitat Loss	18% of insects, 16% of plants and 8% of vertebrates lose over half their climatically determined geographic range	6% of insects, 8% of plants and 4% of vertebrates lose over half their climatically determined geographic range
Permafrost thawing	1.5 – 2.5 million km^2 greater than at 1.5°C	Woody shrubs encroaching into the tundra already at 1°C
Arctic Ocean	At least one sea ice-free summer per decade	One sea ice-free summer per century
Coral reefs	largely disappear (>99% loss)	decline by 70-90%
Fisheries Global annual marine catch (one model)	over 3 million tonnes lower	1.5 million tonnes lower
Greater risk at 2°C than 1.5°C is specified but not quantified[362] • Droughts and precipitation deficits; • Heavy precipitation events; • Heavy precipitation associated with tropical cyclones; • Larger area affected by flood hazards due to precipitation; • Spread of invasive species • Forest fires • Marine ice sheet instability in Antarctica and/or irreversible loss of the Greenland ice sheet could be triggered around 1.5°C to 2°C of global warming • Oceans (greater risk at 2°C spanning several impacts including species range shift and impacts of ocean acidification on marine species)		

Note: Impacts above are attributed a confidence level of at least medium in the IPCC report's Summary for Policymakers

Source: IPCC Special Report on global warming of 1.5°C

[362] Some of these impacts are regional rather than global, though regions in this context are large. E.g. heavy precipitation events are projected to be higher in northern hemisphere high latitude/high elevation regions, eastern Asia and eastern North America. More specific phenomena within these categories may be quantified in the underlying IPCC report.

	At 2°C	At 1.5°C
Populations exposed to climate-related risks and susceptible to poverty	Numbers affected expected to increase	Several hundred million fewer people affected than at 2°C by 2050.
Water stress	Additional 8% of world's population affected (based on year 2000 population)	Affects up to 50% less of the world's population compared to 2°C
Greater risk at 2°C than 1.5°C is specified but not quantified • Human health: heat-related morbidity & mortality, ozone-related mortality • Vector-borne diseases (e.g. malaria, dengue): increased risk, shifting geographic range • Crops (cereals, rice): reductions in yields and/or nutritional quality • Reductions in projected food availability • Risks to global aggregated economic growth • Exposure to multiple, compound climate-related risks • Greater adaptation needs		

Note: Impacts above are attributed a confidence level of at least medium in the IPCC report's Summary for Policymakers

Source: IPCC Special Report on global warming of 1.5°C

2. The need to adapt in the EU

Successful mitigation action is the first necessary step to reduce the risk of climate change. However, in parallel, the EU economy as a whole must adapt to the risks that will result from already committed emissions. These risks grow as we lag behind schedule in stabilising temperatures. Limiting global warming to 1.5°C, compared with 2°C, could reduce the number of people susceptible to poverty globally[363] by up to several hundred million by 2050. Each 0.5ºC of warming avoided can be significant, increasing the chances of achieving SDGs related to poverty, hunger, health, water, cities and ecosystems. Among others, the EU agricultural, forestry, arctic and coastal dependent communities would benefit significantly as the adaptation of fragile ecosystems and the services they provide (e.g. climate and water regulation) would be more effective. In general, overshooting the 1.5ºC limit will make climate-resilient development pathways (CRDPs) more elusive and impacts on water-energy-food-biodiversity links more difficult to manage.

Conventional and incremental approaches to adaptation that do not consider long-term sustainable development or consider adaptation and mitigation separately will not deliver the Paris Agreement. More emphasis on 'transformational' adaptation measures as a complement to 'incremental' adaptation may be required[364]. These adaptation measures and options may

[363] Summary for Policymakers, IPCC Special Report, Global Warming of 1.5°C, B.5.1

[364] Transformational adaptation, according to the IPCC (2014 AR5, Chapter 14: https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-Chap14_FINAL.pdf) "seeks to change the fundamental attributes of systems in response to actual or expected climate and its effects, often at a scale and ambition greater than incremental activities. It includes changes in activities, such as changing livelihoods from cropping to livestock or by migrating to take up a livelihood elsewhere, and also changes in our perceptions and paradigms about the nature of climate change, adaptation, and their relationship to other natural and human systems". See also EEA 2017 climate, impacts and vulnerability report and 2016 EEA report on Urban adaptation to CC in Europe.

include not only "hard" structural and physical measures (e.g. coastal protection, infrastructure) but also "soft" social policies (e.g. awareness, health services) and governance improvements (e.g. implementation, cross-sector coordination, mainstreaming). A combination of both "hard" and "soft" adaptation may produce best results[365], and joining efforts from several EU Member States may also improve protection, e.g. monitoring and mapping jointly coastal and terrestrial areas for a more reliable early warning of extreme weather[366].

It is necessary to better integrate long-term planning of emissions reduction and adaptation:

a) **Adaptation provides opportunities and economic and social stability** – climate change will interact with other socio-economic developments[367]. It can be expected that climate change adaptation projects or the impact of climate extremes will involve a higher level of public intervention than today[368], which calls for effective and efficient adaptation strategies, particularly at local scale. Public resources may be severely drained if the climate reaches certain tipping points[369]. On the other hand, both public and private investments in adaptation provide opportunities and risk management opportunities that can spur the creation of market niches: e.g. for climate services or green infrastructure. In addition, supporting adaptation in developing countries may also bring stability and security within the EU's borders. The New EU Strategy on Adaptation to Climate Change will have a prominent international dimension.

b) **There are co-benefits and, if done incorrectly, trade-offs between mitigation and adaptation** – so both policies must be developed together as components of any credible long-term climate action. Early integration of both adaptation and mitigation in coherent climate-resilient development pathways entails that specific vulnerabilities are factored in when a given economic sectors starts implementing a decarbonisation strategy. For instance, adaptation must ensure that low-emission agricultural techniques withstand higher temperatures, it must lead to renewable electricity networks that are climate-resilient and protect forests so that they keep functioning as carbon sinks. Transformative climate action in cities, in particular, depends on the right mix of mitigation and adaptation actions to both protect citizens against climate impacts and enable emissions reduction within stringent legal and budgetary boundaries.

(c) **Adaptation improves the functionality and resilience of human and natural systems**. Effective adaptation action reduces both the vulnerability and exposure of natural ecosystems and communities to the risks associated with climate extreme events (floods, wildfires,

[365] OECD (2015), Climate Change Risk and Adaptation - Linking Policy and Economics, http://dx.doi.org/10.1787/9789264234611-en
[366] For example, a new European seabed map stitched together from surveys originally made for navigation has improved storm surge forecasts in the North Sea. See: http://www.emodnet.eu/improving-storm-surge-modelling-north-sea
[367] EEA (2017), Climate change, impacts and vulnerabilities in Europe 2016, https://www.eea.europa.eu/publications/climate-change-impacts-and-vulnerability-2016
[368] Daniel Bailey (2015), The Environmental Paradox of the Welfare State: The Dynamics of Sustainability, New Political Economy, 20:6, 793-811, DOI: 10.1080/13563467.2015.1079169
[369] Steffen et al. (2018), Trajectories of the Earth System in the Anthropocene, Proceedings of the National Academy of Sciences Aug 2018, 115 (33) 8252-8259; DOI: 10.1073/pnas.1810141115

hurricanes, etc.), and improves their capacity to recover and re-establish after a climate-related perturbation. These aspects ensure that the functionality of ecosystems (e.g. absorption of CO_2, provision of services) is maintained over the long-term, or at least that such functionality is recovered shortly after an extreme event. In 2013, the European Commission adopted an EU Adaptation Strategy to tackle climate change risks to the EU economy and society. The 2013 Adaptation Strategy – which will be updated with the New EU Strategy on Adaptation to Climate Change in Q1 2021 – focuses on developing better knowledge and understanding of climate impacts, climate proofing of specific sectoral policies and the promotion of action by Member States and cities through non-legislative means. The recent evaluation of the Strategy highlighted the urgency for action because of the important risks facing the EU in certain economic areas[370]. For instance:

- By the end of the century, under a high emissions scenario[371] and without specific adaptation measures undertaken, the EU could experience a welfare loss of around 2% of GDP per year by 2100, i.e. EUR 240 billion per year from only six impact sectors assessed[372]:
    - Weather-related disasters could affect about two-thirds of the European population annually (351 million people per year)[373], compared with 5% of the population between 1981-2010. This would increase the related fatalities per year by fifty times by the year 2100 (from 3 000 deaths per year presently, to 152 000 deaths per year by 2100)[374];
    - Flooding alone may cost EU countries up to EUR 1 trillion per year in damages by the end of the century. Most of this would be due to coastal flooding (up to EUR 961 billion). Damages from river flooding could also rise to up to EUR 112 billion compared to EUR 5 billion today, and there is considerable increase in river flood risk for Europe even under a 1.5º C warming scenario[375]. This could also affect transport infrastructure. By the end of the century, under a high warming scenario, about 200 airports and 850 seaports of different size across the EU could face the risk of inundation due to higher sea levels and extreme weather events.
- Climate change is already affecting agriculture production both in direct and indirect ways: through temperature and precipitation changes, increasing variability, and extremes. It is also affecting the long-term perspective of agriculture through slow on-setting events such as soil salinization, soil erosion, land degradation and desertification, and sea-level rise. This has a direct impact on production and yields, income and livelihoods, as well as

[370] Report from the Commission to the European Parliament and the Council on the implementation of the EU Strategy on adaptation to climate change.
[371] In this section, the term "high emissions scenario", unless specified otherwise, refers to the IPCC's Representative Concentration Pathway (RCP) 8.5. In the RCP 8.5 scenario, greenhouse gas emissions continue to rise throughout the 21st century.
[372] JRC (2018), Climate Impacts in Europe, Final report of the JRC PESETA III project. doi:10.2760/93257. https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/climate-impacts-europe
[373] Forzieri et al. (2017), Increasing risk over time of weather-related hazards to the European population: a data-driven prognostic study, https://doi.org/10.1016/S2542-5196(17)30082-7
[374] High emissions scenario, in this particular case, means scenario SRES A1B.
[375] Alfieri et al. (2018). Multi-Model Projections of River Flood Risk in Europe under Global Warming. Climate, 2018 6, 16; doi:10.3390/cli6010016: https://www.mdpi.com/2225-1154/6/1/6/pdf

the processing industry altogether accounting for high economic impacts. In a 2°C scenario before 2100, irrigated crop yields are projected to decline in most regions of Europe, with rain-fed yields depending on changes in water availability[376]. At EU level, the prolonged drought of 2018 has triggered higher CAP advanced payments and derogations from greening requirements.[377] Repeated droughts in Europe will have repercussions for climate change mitigation policies: the water and carbon cycles are interlinked because CO_2 rates in the atmosphere increase when terrestrial water storage diminishes: major droughts may cause drastic regional reductions in land carbon sinks[378]. Drought is already ravaging Europe's soils, whose moisture shows a marked decreasing trend over the 1979-2017 period[379]. Furthermore, moisture decrease is a crucial factor in the ferocity and expanded reach of recent forest fires (that would jeopardise viability of forests as carbon sink and the provision of ecosystem services).

- As regards the building sector, new and renovated buildings need to prepare for climate change impacts as they, together with most of the remaining built environment, are particularly vulnerable to: (1) Extreme temperatures affect the comfort of the occupants and building energy efficiency; (2) Climatic conditions (humidity, temperatures) can affect the structural integrity of the constructions; (3) More frequent and intense flooding events can do more harm to more buildings; and (4) Water scarcity could in the future make domestic water supply more expensive. Adaptation may for instance include: (i) Green roofs and walls contribute to reducing the heat island effect and enhance water retention in towns; and (ii) Domestic rain water cisterns contribute to urban water retention and (iii) utilization of energy–efficient building materials contributing to energy efficiency and reducing water consumption..

The PESETA[380] project analysed climate change projections for 2050 considering the Representative Concentration Pathway (RCP) of 8.5 W/m2 (with corresponding global warming levels ranging between 1.6°C and 2.7°C compared to pre-industrial levels), as well as for 1.5°C and 2°C warming conditions. Results show that climate change will pose a threat to global food production in the medium to long term, and that Europe will also be affected. Forced by the projected changes in daily temperature, precipitation, wind, relative humidity, and global radiation, grain maize yields in the EU will decline between 1% and 22%. In addition, wheat yields in Southern Europe are expected to decrease by up to 49%.

The vulnerability of forests and ecosystems to climate change has been highlighted in a number of studies and reports from the European Environment Agency (EEA)[381] and the Joint Research Centre (JRC)[382].

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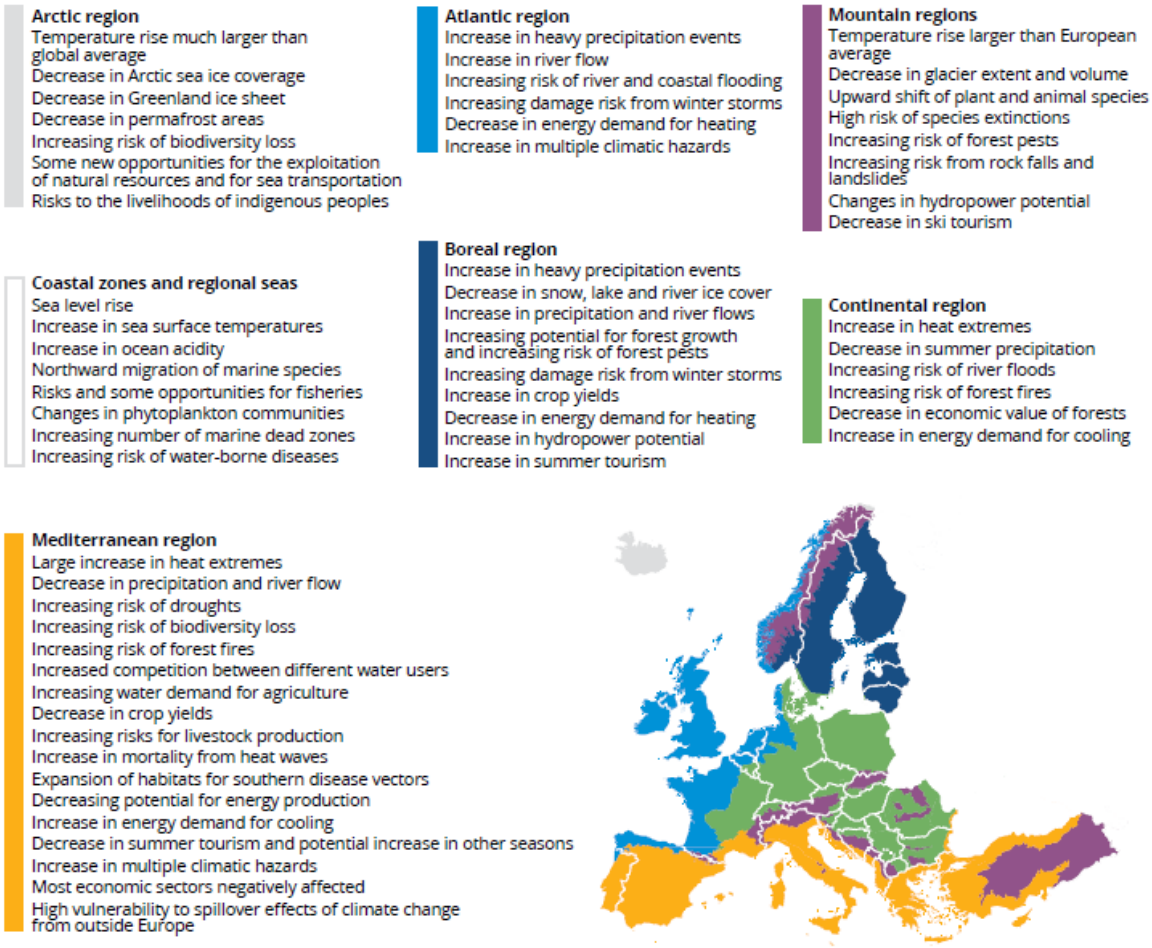
[376] Commission Staff Working Document: Evaluation of the EU Strategy on Adaptation to Climate Change SWD(2018)461final.
[377] Commission Press release – "Commission offers further support to European farmers dealing with droughts", Brussels, 2 August 2018. http://europa.eu/rapid/press-release_IP-18-4801_en.htm
[378] Humphrey et al. (2018), Sensitivity of atmospheric CO_2 growth rate to observed changes in terrestrial water storage, https://doi.org/10.1038/s41586-018-0424-4
[379] Copernicus Climate Services (C3S): European State of the Climate 2017: https://climate.copernicus.eu/climate-2017-european-wet-and-dry-indicators
[380] PESETA: https://ec.europa.eu/jrc/en/peseta-iv
[381] https://www.eea.europa.eu/publications/climate-change-impacts-and-vulnerability-2016
[382] https://ec.europa.eu/jrc/en/peseta-iii ; https://ec.europa.eu/jrc/en/peseta-iv

In addition, climate-change related risks can also have implications on the assessment of medium-term inflation outlook by central banks. Recently, the European Central Bank (ECB) stated that catastrophic climate change could force the ECB to rethink its current monetary policy framework[383]. The EIB will end financing for fossil fuel energy projects from 2021[384]

Looking at risks from a more territorial angle, evidence is mounting on the distributional effects of climate impacts across Europe. Impacts and opportunities will not be equally spread across the EU territory, as shown in the map below:

Figure 22: Risk of climate change impacts across Europe



Source: European Environment Agency. https://www.eea.europa.eu/publications/climate-change-impacts-and-vulnerability-2016

There are specific climate risks that are of major concern to some EU regions and communities. In the absence of adaptation, for instance[385]:

[383] Speech by Benoît Cœuré, Member of the Executive Board of the ECB, at a conference on "Scaling up Green Finance: The Role of Central Banks", organised by the Network for Greening the Financial System, the Deutsche Bundesbank and the Council on Economic Policies, Berlin, 8 November 2018

[384] https://www.eib.org/en/press/all/2019-313-eu-bank-launches-ambitious-new-climate-strategy-and-energy-lending-policy.htm#

[385] Where not otherwise specified, information provided comes from Commission Staff Working Document: Evaluation of the EU Strategy on Adaptation to Climate Change SWD(2018)461final.

- While Europe as a whole will be more prone to flood risk (with mean annual river flow set to increase), water stress will be more pronounced in Southern European regions[534], and may well cause tensions between different users of dwindling reservoirs and aquifers. With 2°C warming, river flows in Mediterranean regions are expected to fall in all seasons.
- Higher temperatures by the end of the century are expected to have various impacts such as a 10-15% loss in outdoor labour productivity in several Southern European countries as well as increases in heat-related mortality.
- Habitat loss and forest fires are also serious risks. 16% of the present Mediterranean climate zone (an area half the size of Italy) could become arid by the end of the century. Drier soils in the Mediterranean also increase the area prone to forest fires.
- Loss of Alpine tundra, even at 2°C could have important impacts on water regulation (including for human consumption), as well as economic impacts including in the tourism sector.
- Specific risks (e.g. hurricanes, sea level rise, extreme heat) threaten to unravel EU efforts to support its nine Outermost Regions, most of them small and isolated islands. The impacts of hurricanes Irma and Maria on the Caribbean in 2017, and notably on St-Martin, Guadeloupe and Martinique (three of the EU's outermost regions) came as a stark warning of the potential impacts such regions face.
- Transport: From road and rail networks to ports, airports and inland waterways, critical transport resources are facing unprecedented threats from a climate, which is already changing. Spain, for example, has just suffered the most powerful storms experienced in decades, destroying bridges, cutting off roads and railway lines and submerging entire towns in coastal areas. Flooding from high precipitation and extreme storms, in possible association with related impacts including landslides and slope failures, will bring major risks across the region for all modes of transport (road - and airport - infrastructure, railway and inland waterways). Rising sea levels and greater wave activity causing erosion put vital coastal transport infrastructure (i.e. coastal roads, railways, seaports and airports) at risk. Over 60% of EU seaports[386] may be under high inundation risk by 2100, causing disruptions to operations and damages to port infrastructure and vessels, especially along the North Sea coast, where the traffic of over 500 ports accounts for up to 15% of the world's cargo transport. Rising temperatures linked to increased heat waves and drier and hotter summers will affect roads, where pavement damages, damages to bridges and increased landslides in mountainous areas are among key risks. Areas considered particularly worthy of more detailed analysis include E-Roads in Southern Europe (South-Eastern France, Italy, Western Balkans, Portugal, Spain, Greece, and Turkey) as well as in Nordic countries (Norway, Sweden and Finland). Climate proofing not only individual infrastructure investment projects, but also existing transport corridors,

[386] UNECE: https://www.unece.org/info/media/presscurrent-press-h/transport/2020/unece-study-maps-transport-infrastructure-at-high-risk-due-to-climate-change-in-pan-european-region-and-canada/doc.html

networks and systems will be increasingly relevant, as the majority of the existing infrastructure is built for the past climatic conditions.

- On major rail networks – where potential impacts include buckling of tracks, slope failures and speed restrictions – infrastructure in the Mediterranean (Spain, Italy, France), northern Europe, and Croatia are among those that could warrant more in-depth review.
- Warming is also associated with increased navigational risks on inland waterways, with significant implications for the transport of goods and people, which is already problematic in parts of central Europe.
- Cities as well as rural areas are directly and indirectly impacted by the impacts of climate change. As the level of governance closest to citizens, they are often at the forefront of responding to natural disasters and taking action on mitigate emissions and adapt to climate change. Through their concentration of people and assets, cities are the major consumers of energy and emitters of greenhouse gas emissions, but have also pioneered actions to reduce emissions and adapt to climate. Including through initiatives such as the EU and Global Covenant of Mayors, committing to reduce emissions by at least 40% by 2030, and taking action to adapt to climate change".

The EU Taxonomy on sustainable finance will also address climate related risks.

3. Mitigation and adaptation: co-benefits and trade-offs

Measures to cut emissions can undermine resilience to climate change in certain contexts, and viceversa. On the other hand, there are adaptation measures that are also beneficial for decarbonisation (e.g. protection of certain coastal ecosystems that both tackle sea level rise and remove CO_2). A recent OECD report[387] highlights that climate investments and projects must consider the links between adaptation and mitigation to minimise climate risk: the greater the perceived risks of a project, the higher the returns investors will demand, and the higher the costs passed onto end users and government sources of funding. The report provides a summary of potential synergies and trade-offs between adaptation and mitigation measures:

[387] OECD (2017), Investing in Climate, Investing in Growth, OECD Publishing, Paris. http://dx.doi.org/10.1787/9789264273528-en

Table 44: Co-benefits and trade-offs between adaptation and mitigation for agriculture and forestry[388]

	Positive for mitigation	Potential trade-off with mitigation
Positive for adaptation	Reduced deforestation: sequesters carbon and provides ecosystems services Agricultural practices (e.g. no till) that can sequester carbon while boosting farmers income Wetland restoration: carbon sequestration and reduced flood risk Renewable energy – wind and solar: lower water use than thermal generation	Desalination: addresses water shortage but is energy intensive Increased irrigation: helps farmers manage variable precipitation but can be energy intensive Construction of hard defences: reduces the risk of extreme events, but the construction may in some cases lead to substantial greenhouse gas emissions Air-conditioning: reduces the impact of high temperatures, but is energy intensive. However, redesign of buildings to enable passive cooling and natural ventilation in buildings is a better and more sustainable solution.
Potential trade-off with adaptation	Inappropriate expansion of biofuels: could exacerbate food price shocks if biofuels displace crops Hydropower: could increase the complexity of managing water resources	N/A

In some areas, the potential to maximise the mutual reinforcement between adaptation and mitigation should guide long-term EU efforts to decarbonise and climate-proof the economy. Examples for ecosystems, energy and cities are mentioned below.

Land and coastal ecosystems

Terrestrial and marine ecosystems globally absorb around 50% of anthropogenic emissions[389]. The rest remains for prolonged times in the atmosphere, increasing greenhouse gas concentrations and causing climate change.

Climate change is affecting ecosystems, modifying species range and prompting natural vegetation changes. Global warming has led to shifts of climate zones in many world regions, including expansion of arid climate zones and contraction of polar climate zones. As a

[388] EEA has published a report CCA and agriculture which goes much more in details about adaptation measures and its benefits for mitigation and biodiversity. https://www.eea.europa.eu/publications/cc-adaptation-agriculture

[389] Around 50% globally, according to A. P. Ballantyne, C. B. Alden, J. B. Miller, P. P. Tans, J. W. C. White. Increase in observed net carbon dioxide uptake by land and ocean during the past 50 years. Nature, 2012; 488 (7409): 70 DOI: 10.1038/nature11299

consequence, many plant and animal species have experienced changes in their ranges, abundances, and shifts in their seasonal activities. 7.5% of global land area will change from one ecosystem type to another at 1.5°C, and 13% at 2°C.

This absorption capacity has its own limits. In case of oceans, this uptake is associated with increased acidification, having negative impacts on marine biodiversity. In case of terrestrial ecosystems, ecosystem degradation and deforestation actually result in significant greenhouse gas emissions, while being detrimental for biodiversity. Preserving and restoring terrestrial and marine ecosystems contribute both to mitigation and adaptation (for example, they contribute to water retention, control floods and protect against soil erosion or air pollution).

In general, the joint implementation of adaptation and mitigation strategies contribute to the health, functionality and resilience of ecosystems, and therefore improve the availability and delivering of goods and services to EU citizens. Many environmental, welfare and climate objectives may be reached simultaneously through ecosystem-based initiatives[390]. For example, marine vegetated habitats (seagrasses, salt-marshes, mangroves and others) contribute 50% of carbon storage in marine sediments despite occupying only 0.2% of the ocean surface globally. They reduce wave energy and raise the seafloor, and as such moderate the impacts of sea level rise and contribute to safeguard people, infrastructure, and property along coastlines[391].

Land restoration, reforestation, afforestation and reduced and avoided degradation in forests, as well as rehabilitation of wetlands, contributes to and increased land use sink. Forests offer a good example of the co-benefits that can arise from coordinated adaptation and mitigation. Indeed, EU forests absorb the equivalent of just over 400 $MtCO_2$, or almost 10% of total EU greenhouse gas emissions each year. At the same time, they lower temperatures, act as a buffer for hydrological extremes and purify water, which means they are also crucial in adapting to climate change. Recent case-studies in Ireland, Spain and the Czech Republic have shown that adaptation measures and good forestry practices enhance the role of forests as carbon sinks[392]. It is important to act with a long-term perspective because aging and degraded forests, agro-forestry systems and more recent forest plantations all require adaptation planning today in order to withstand a changing climate.

Energy[393]

Due to climate change alone, and in the absence of adaptation, annual damage to Europe's critical infrastructure could increase ten-fold by the end of the century under business-and-usual scenarios[394], from the current EUR 3.4 billion to EUR 34 billion. Losses would be highest for the industry, transport, and energy. One of the greatest challenges is how to assess

[390] Faivre et al. 2018; https://doi.org/10.1016/j.ijdrr.2017.12.015
[391] Duarte, C.M., Losada, I.J., Hendriks, I.E., Mazarrasa, I., Marbà, N. The role of coastal plant communities for climate change mitigation and adaptation. Nature Climate Change, 3 (11), pp. 961-968 (2013).
[392] European Forest Institute – 2018
https://www.efi.int/publications-bank/climate-smart-forestry-mitigation-impacts-three-european-regions
[393] https://www.eea.europa.eu/publications/adaptation-in-energy-system
[394] Forzieri et al. (2018), Escalating impacts of climate extremes on critical infrastructures in Europe, Global Environmental Change 48, 97–107,

impacts on energy production which may occur as a consequence of the projected increase in the intensity of extreme weather events, as research gaps include economic modelling of extreme events and vulnerabilities of transmission infrastructure[395].

Impacts on renewable energy sources are of specific concern, given their critical contribution to emissions reduction. There is some evidence on impacts on hydropower production due to water scarcity, but also on wind, solar, biomass[396]. As regards hydropower in particular, the main mechanisms through which climate change can affect hydropower production are changes in river flow, evaporation, and dam safety[397]. For Europe, most studies show a positive effect of climate change impacts on hydropower for Northern Europe and a negative effect for South and Eastern Europe[557] [398] [399] [400] [401]. The extent to which climate change affects hydropower in Europe as a whole differs among the studies from almost no effect[558] to decreases of 5-10% by the end of the century or even before[559] [402]. Adaptation measures in hydropower production could offset these impacts in Europe on a yearly average (not for all months of the year): e.g. by increasing efficiency[560] or water storage[403]. As regards solar and wind energy, there are studies that indicate that production might be negatively affected on some regions in the EU[404] [405] [406].

Thermoelectric generation will be under more pressure in Southern European regions where their water cooling needs may no longer be met: they may generate up to 20% less under a 3ºC scenario; 15% less in a 2ºC world. [555]Thermal electricity generation may suffer most from water stress in the near term in the Mediterranean, France, Germany and Poland[407].

While the magnitude of these impacts is not expected to jeopardise Europe's long-term decarbonisation path, it may entail higher costs and different regional energy mixes, unless adaptive measures are deployed such as increased plant efficiencies, replacement of cooling systems and fuel switches[560]. Private stakeholders in the energy system and EU and national policies should reinforce the right market framework to ensure that the climate impacts do not jeopardise the EU's stability and security of energy supply. Transitions in the electricity

[395] Chandramowli et Felder (2014), Impact of climate change on electricity systems and markets – A review of models and forecasts, https://doi.org/10.1016/j.seta.2013.11.003
[396] See COACCH 1st synthesis report.
[397] Mideksa and Kalbekken (2010), The impact of climate change on the electricity market: A review, https://doi.org/10.1016/j.enpol.2010.02.035
[398] Hamududu and Killingtveit (2012), Assessing Climate Change Impacts on Global Hydropower, doi:10.3390/en5020305
[399] Lehner et al.,(2005), The impact of global change on the hydropower potential of Europe: a model-based analysis, https://doi.org/10.1016/j.enpol.2003.10.018
[400] Van Vliet et al,(2016), Power-generation system vulnerability and adaptation to changes in climate and water resources, https://doi.org/10.1038/nclimate2903
[401] Teotónio et al.(2017), Assessing the impacts of climate change on hydropower generation and the power sector in Portugal: A partial equilibrium approach, https://doi.org/10.1016/j.rser.2017.03.002
[402] Chandramowli et Felder (2014), Impact of climate change on electricity systems and markets – A review of models and forecasts, https://doi.org/10.1016/j.seta.2013.11.003
[403] Berga (2016), The Role of Hydropower in Climate Change Mitigation and Adaptation: A Review, https://doi.org/10.1016/J.ENG.2016.03.004
[404] Karnauskaset al. (2018), Southward shift of the global wind energy resource under high carbon dioxide emissions, https://doi.org/10.1038/s41561-017-0029-9
[405] Tobin et al. (2018), Vulnerabilities and resilience of European power generation to 1.5 °C, 2 °C and 3 °C warming, https://doi.org/10.1088/1748-9326/aab211
[406] Jerez et al. (2015), The impact of climate change on photovoltaic power generation in Europe, https://doi.org/10.1038/ncomms10014
[407] Behrens et al. (2017): Climate change and the vulnerability of electricity generation to water stress in the European Union, https://doi.org/10.1038/nenergy.2017.114

sector should encompass both mitigation and adaptation planning, if they are to sustain and secure a sustainable water–energy nexus in the next few decades.

The 2019 JRC report[408] provides further reading on the water-energy nexus. Water availability is among the key constraints affecting the European energy sector, which currently requires 74 billion m3/year of freshwater, similar to the water needs of agriculture. The decarbonisation of the energy system could reduce its water needs by 38% by 2050, yet water availability will play an essential role on the way to climate neutrality by 2050. At the same time, projections indicate that water resources are expected to be under major stress, primarily due to climate change. Higher water stress is expected in Mediterranean regions and extreme weather variability is also expected in north-west Europe. That may lead to increased strain in regions where freshwater is key for cooling thermal power plants or where hydropower capacity plays a significant role in the power system.

Cities

The need to integrate adaptation and mitigation pathways is most apparent in the transformation of European cities. They are home to 360 million people, i.e. 73% of Europe's population, and account for 80% of the continent's energy consumption and for 85% of Europe's GDP[409]. Yet, only around 40% of EU cities with more than 150.000 inhabitants have adopted adaptation plans to protect citizens from climate impacts. Globally, a 2015 OECD report recognises that, in spite of the important role local authorities have to deliver climate resilience through regulatory frameworks and incentives, "support for urban adaptation remains uneven"[527].

Trade-offs between mitigation and adaptation goals must be avoided in cities. In general, for example, densification may benefit emissions reduction (e.g. less transport needs), but can also increase vulnerability to regional climate impacts (e.g. more people and assets in less space when a flood occurs). Cities also suffer from higher temperatures than the surrounding areas, due to the concentration of built environment ("heat island effect").

There are opportunities to optimise climate action when developing joint mitigation and adaptation in urban planning. For example, urban green spaces, corridors and green and blue infrastructure can deliver adaptation benefits and absorb emissions and pollution, and permeable surfaces to address floods in urban areas. Cities will also be major clients for climate services and emerging businesses may provide solutions to city planners that combine optimal mitigation and adaptation ideas. Cities that prioritise resilient and low-emission urban development at once will enjoy a competitive advantage and attract investments[410].

[408] https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/water-energy-nexus-europe
[409] HELIX - https://www.helixclimate.eu/
[410] E3G (2014), "Underfunded, underprepared, underwater? Cities at risk".

Annex 10: Glossary, Indices, Abbreviations

Glossary

The majority of the following definitions are derived from the IPCC Glossary[411] or otherwise indicated:

Adaptation: In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate and its effects.

Adaptation options: The array of strategies and measures that are available and appropriate for addressing adaptation. They include a wide range of actions that can be categorized as structural, institutional, ecological or behavioural.

Carbon dioxide (CO2): A naturally occurring gas, CO2 is also a by-product of burning fossil fuels (such as oil, gas and coal), of burning biomass, of land use changes (LUC), and of industrial processes (e.g. cement production). It is the principal anthropogenic greenhouse gas (GHG) that affects the Earth's radiative balance. It is the reference gas against which other GHGs are measured and therefore has a Global Warming Potential (GWP) of 1.

Climate: Climate in a narrow sense is usually defined as the average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The classical period for averaging these variables is 30 years, as defined by the World Meteorological Organization. The relevant quantities are most often surface variables such as temperature, precipitation and wind. Climate in a wider sense is the state, including a statistical description, of the climate system.

Climate change: Climate change refers to a change in the state of the climate that can be identified (e.g. by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcing such as modulations of the solar cycles, volcanic eruptions and persistent anthropogenic changes in the composition of the atmosphere or in land use. Note that the Framework Convention on Climate Change (UNFCCC), in its Article 1, defines climate change as: 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods'. The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition and climate variability attributable to natural causes.

[411] IPCC Glossary accompanying the special report on global warming of 1.5°C: https://www.ipcc.ch/report/sr15/glossary/

Climate extreme (extreme weather or climate event): The occurrence of a value of a weather or climate variable above (or below) a threshold value near the upper (or lower) ends of the range of observed values of the variable. For simplicity, both extreme weather events and extreme climate events are referred to collectively as 'climate extremes.'

Climate neutrality: Concept of a state in which human activities result in no net effect on the climate system. Achieving such a state would require balancing of residual emissions with emission (carbon dioxide) removal as well as accounting for regional or local biogeophysical effects of human activities that, for example, affect surface albedo or local climate.

Climate projection: A climate projection is the simulated response of the climate system to a scenario of future emission or concentration of GHG and aerosols, generally derived using climate models. Climate projections are distinguished from climate predictions by their dependence on the emission/concentration/radiative forcing scenario used, which is in turn based on assumptions concerning, for example, future socioeconomic and technological developments that may or may not be realized.

CO2 equivalent (CO2-eq) emission: The amount of carbon dioxide (CO2) emission that would cause the same integrated radiative forcing or temperature change, over a given time horizon, as an emitted amount of a greenhouse gas (GHG) or a mixture of GHGs. There are a number of ways to compute such equivalent emissions and choose appropriate time horizons. Most typically, the CO2-equivalent emission is obtained by multiplying the emission of a GHG by its Global Warming Potential (GWP) for a 100 year time horizon. For a mix of GHGs it is obtained by summing the CO2-equivalent emissions of each gas. CO2-equivalent emission is a common scale for comparing emissions of different GHGs but does not imply equivalence of the corresponding climate change responses. There is generally no connection between CO2-equivalent emissions and resulting CO2-equivalent concentrations.

Cost-benefit analysis: Monetary assessment of all negative and positive impacts associated with a given action. Cost-benefit analysis enables comparison of different interventions, investments or strategies and reveal how a given investment or policy effort pays off for a particular person, company or country. Cost-benefit analyses representing society's point of view are important for climate change decision making, but there are difficulties in aggregating costs and benefits across different actors and across timescales.

Disaster[412]: Severe alterations in the normal functioning of a community or a society due to hazardous physical events interacting with vulnerable social conditions, leading to widespread adverse human, material, economic, or environmental effects that require immediate emergency response to satisfy critical human needs and that may require external support for recovery.

Environmental Impact Assessment (EIA): the process of carrying out an EIA as required by Directive 2011/92/EU, as amended by Directive 2014/52/EU on assessment of the effects

[412] IPCC SREX Glossary: https://archive.ipcc.ch/pdf/special-reports/srex/SREX-Annex_Glossary.pdf

of certain public and private Projects on the environment. The main steps of the EIA process are: preparation of the EIA Report, publicity and consultation, and decision-making.

Exposure[412]: The presence of people; livelihoods; environmental services and resources; infrastructure; or economic, social, or cultural assets in places that could be adversely affected.

Extreme weather event: An extreme weather event is an event that is rare at a particular place and time of year. Definitions of rare vary, but an extreme weather event would normally be as rare as or rarer than the 10^{th} or 90^{th} percentile of a probability density function estimated from observations. By definition, the characteristics of what is called extreme weather may vary from place to place in an absolute sense. When a pattern of extreme weather persists for some time, such as a season, it may be classed as an extreme climate event, especially if it yields an average or total that is itself extreme (e.g. drought or heavy rainfall over a season).

Global Warming Potential (GWP): An index, based on radiative properties of GHG, measuring the radiative forcing following a pulse emission of a unit mass of a given greenhouse gas in the present day atmosphere integrated over a chosen time horizon, relative to that of carbon dioxide. The GWP represents the combined effect of the differing times these gases remain in the atmosphere and their relative effectiveness in causing radiative forcing. The Kyoto Protocol is based on GWPs from pulse emissions over a 100-year time frame.

Greenhouse gas (GHG): Greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of terrestrial radiation emitted by the earth's surface, the atmosphere itself, and by clouds. This property causes the greenhouse effect. Water vapour (H2O), carbon dioxide (CO2), nitrous oxide (N2O), methane (CH4) and ozone (O3) are the primary GHGs in the earth's atmosphere. Moreover, there are a number of entirely human-made GHGs in the atmosphere, such as the halocarbons and other chlorine- and bromine-containing substances, dealt with under the Montreal Protocol. Beside CO2, N2O and CH4, the Kyoto Protocol deals with the GHGs sulphur hexafluoride (SF6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs).

Hazard: The potential occurrence of a natural or human-induced physical event or trend that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources.

Infrastructure: See the definition in chapter **Error! Reference source not found.** of this guidance.

Impacts (consequences, outcomes): The consequences of realized risks on natural and human systems, where risks result from the interactions of climate-related hazards (including extreme weather and climate events), exposure, and vulnerability. Impacts generally refer to effects on lives, livelihoods, health and wellbeing, ecosystems and species, economic, social and cultural assets, services (including ecosystem services), and infrastructure. Impacts may be referred to as consequences or outcomes, and can be adverse or beneficial.

Representative concentration pathways (RCPs): Scenarios that include time series of emissions and concentrations of the full suite of greenhouse gases (GHGs) and aerosols and chemically active gases, as well as land use/land cover (Moss et al., 2008). The word representative signifies that each RCP provides only one of many possible scenarios that would lead to the specific radiative forcing characteristics. The term pathway emphasizes the fact that not only the long-term concentration levels, but also the trajectory taken over time to reach that outcome are of interest (Moss et al., 2010). RCPs were used to develop climate projections in CMIP5.

RCP2.6: One pathway where radiative forcing peaks at approximately 3 W/m² and then declines to be limited at 2.6 W/m² in 2100 (the corresponding Extended Concentration Pathway, or ECP, has constant emissions after 2100).

RCP4.5 and RCP6.0: Two intermediate stabilisation pathways in which radiative forcing is limited at approximately 4.5 W/m² and 6.0 W/m² in 2100 (the corresponding ECPs have constant concentrations after 2150).

RCP8.5: One high pathway which leads to > 8.5 W/m² in 2100 (the corresponding ECP has constant emissions after 2100 until 2150 and constant concentrations after 2250).

Risk: The potential for adverse consequences where something of value is at stake and where the occurrence and degree of an outcome is uncertain. In the context of the assessment of climate impacts, the term risk is often used to refer to the potential for adverse consequences of a climate-related hazard, or of adaptation or mitigation responses to such a hazard, on lives, livelihoods, health and wellbeing, ecosystems and species, economic, social and cultural assets, services (including ecosystem services), and infrastructure. Risk results from the interaction of vulnerability (of the affected system), its exposure over time (to the hazard), as well as the (climate-related) hazard and the likelihood of its occurrence.

Risk assessment: The qualitative and/or quantitative scientific estimation of risks.

Risk management: Plans, actions, strategies or policies to reduce the likelihood and/or consequences of risks or to respond to consequences.

Sensitivity[413]: Sensitivity is the degree to which a system is affected, either adversely or beneficially, by *climate variability* or change. The effect may be direct (e.g. a change in crop yield in response to a change in the mean, range or variability of temperature) or indirect (e.g. damages caused by an increase in the frequency of coastal flooding due to *sea-level rise*).

Slow onset events: Slow onset events include e.g. temperature increase, sea-level rise, desertification, glacial retreat and related impacts, ocean acidification, land and forest degradation, average precipitation, salinization, and loss of biodiversity. As regards the statistical distribution of a climate variable (and how it may shift in a changing climate), slow onset events will often reflect how the mean value is changing (whereas extreme events are related to the tail ends of the distribution).

[413] IPCC AR4 Glossary WG2: https://archive.ipcc.ch/pdf/glossary/ar4-wg2.pdf

Strategic Environmental Assessment (SEA): the process of carrying out an environmental assessment as required by Directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment. The main steps of the SEA process are preparation of the SEA Report, publicity and consultation, and decision-making.

Urban resilience: The measurable ability of any urban system, with its inhabitants, to maintain continuity through all shocks and stresses, while positively adapting and transforming towards sustainability.

Vulnerability [IPCC AR4[414]]: Vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of *climate change*, including *climate variability* and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its *sensitivity*, and its adaptive capacity.

Vulnerability [IPCC AR5[415]**]:** The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.

Index of Tables and Boxes

[414] IPCC AR4 Climate Change 2007: Impacts, Adaptation, and Vulnerability, Appendix I: Glossary, https://www.ipcc.ch/site/assets/uploads/2018/02/ar4-wg2-app-1.pdf

[415] IPCC AR5 SYR, Synthesis Report, Annex II: Glossary, https://www.ipcc.ch/site/assets/uploads/2019/01/SYRAR5-Glossary_en.pdf

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Abbreviations

BBNJ	Biological Diversity of Areas Beyond National Jurisdiction
BRG	Better Regulation Guidelines
CAP	Common Agricultural Policy
CBA	Cost Benefit Analysis
CBD	Convention on Biological Diversity
CEF	Connecting Europe Facility
CEN	European Committee for Standardization
CEOS	Committee on Earth Observation
CES	Central Southern Europe
CGE	Computable General Equilibrium
CIS	Common Implementation Strategy
CLMS	Copernicus Land Monitoring Services

CMA	Meeting of the Parties to the Paris Agreement
COP	Conference of The Parties
CPR	Common Provisions Regulation
CSR	Corporate Social Responsibility
CWP	Commission Work Program
DAC	Development Assistance Committee
DG CLIMA	Directorate-General for Climate Action
DRF	Disaster Risk Financing
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
DWD	Drinking Water Directive
EAD	Expected Annual Damage
EAFRD	European Agricultural Fund for Rural Development
EASAC	European Academies' Science Advisory Council
EBRD	European Bank for Reconstruction and Development
EC	European Commission
ECA	European Court of Auditors
ECB	European Central Bank
EEA	European Environmental Agency
EFFIS	European Forest Fire Information System
EFSA	European Food Safety Authority
EFSD	European Fund for Sustainable Development
EFTA	European Free Trade Association
EIB	European Investment Bank
EIOPA	European Insurance and Occupational Pensions Authority
EIP	European Innovation Partnership
EMFF	European Maritime And Fisheries Fund
EMS	Emergency Management Service
ENER	Directorate-General for Energy
ENV	Directorate-General for Environment
ERDF	European Regional Development Fund
ESF	European Social Fund
ESIF	European Structural and Investment Funds
ESPON	European Spatial Planning Observation Network
ESTAT	Eurostat
ETR	Environmental Tax Reform
ETS	Energy Trading System
EU	European Union
FAO	Food and Agriculture Organization
FDI	Foreign Direct Investment
FISE	Forest Information System for Europe
GAR	Global Assessment Report on Disaster Risk Reduction
GCCA	Global Climate Change Alliance
GDP	Gross Domestic Product
GHG	Greenhouse Gases
GI	Green Infrastructure
GIS	Geospatial Information System
GVA	Gross Value Added
GWP	Global Warming Potential
HARCI	Harmonized Grids of Critical Infrastructures In Europe
IA	Impact Assessment
IEA	International Energy Agency
IIA	Inception Impact Assessment
ILO	International Labour Organization
IMF	International Monetary Fund
IOT	Internet of Things
IPCC	Intergovernmental Panel on Climate Change
IPSF	International Platform for Sustainable Finance
IRDR	Integrated Research on Disaster Risk
ISO	International Standardisation Organisation
ISPRS	International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences
ISSG	Inter-Service Steering Group
IUCN	International Union for Conservation of Nature
JRC	Joint Research Centre
KIC	Knowledge and Innovation Community
LAU	Local Administrative Units
MFF	Multiannual Financial Framework
MMR	Monitoring Mechanism Regulation
MRE	Monitoring, Reporting and Evaluation
MS	Member States
NACE	Nomenclature Statistique des Activités Économiques dans la Communauté Européenne
NAIAD	Nature Insurance Value: Assessment and Demonstration
NAP	National Adaptation Plan
NAS	National Adaptation Strategy

NATCAT	Natural Catastrophes
NBS	Nature Based Solution
NFD	Non-Financial Disclosure
NFRD	Non-Financial Reporting Directive
NGO	Non-Governmental Organization
NWRM	Natural Water Retention Measures
OECD	Organisation For Economic Co-Operation And Development
OLS	Ordinary Least Squares (OLS) Technique Is The Most Popular Method Of Performing Regression Analysis And Estimating Econometrics
OPC	Open Public Consultation
RCP	Representative Concentration Pathways
RDI	Research, Development And Innovation
RFMO	Regional Fisheries Management Organisations And Agreements
RSB	Regulatory Scrutiny Board
SDG	Sustainable Development Goal
SEAP	Sustainable Energy Action Plan
SECAP	Sustainable Energy And Climate Action Plan
SIDS	Small Island Developing States
SME	Small Medium Enterprises
TEN-E	Trans-European Networks For Energy
TEN-T	Trans-European Transport Network
TFEU	Treaty On The Functioning Of The European Union
UCPM	Union Civil Protection Mechanism
UHI	Urban Heat Effect
UN	United Nations
UNDRR	United Nations Office For Disaster Risk Reduction
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention On Climate Change
WEF	World Economic Forum
WEI	Water Exploitation Index
WEO	World Energy Outlook,
WFD	Water Framework Directive
WHO	World Health Organization
WMO	World Meteorologic Organization